CONCEPTUAL DESIGN OF TRANSFER STATION/MATERIALS & ENERGY RECOVERY FACILITY CITY OF BERKELEY

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SOLID WASTE MANAGEMENT CENTER

FINAL REPORT
NOVEMBER 1980
VOLUME I

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FINAL REPORT
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VOLUME I

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CHAPTER 1

PROJECT SYNOPSIS

PROJECT EVOLUTION

The City of Berkeley's proposed Solid Waste Management Center (SWMC) is the newest step in a well-balanced and diligently developed solid waste management system.

The system itself already embraces the fundamental steps necessary for optimal operation of the SWMC: source separation, recycling centers and a bottle ordinance passed but currently under litigation.

It is envisioned that the SWMC would provide space for a recycling center with storage capabilities for curbside collection of source-grouped materials. Source separation through curbside collection in conjunction with materials brought to the facility by the general public would, it is anticipated, recover some 15% or more of the total Berkeley waste stream.

The remaining waste requiring disposal would be handled at the proposed transfer station/materials and energy recovery facility, which would have two main functions: to receive, process and recover (secondary materials) and convert (to energy) generated wastes; and to transfer the wastes to a distant landfill in the event of extended downtime of the process and/or energy conversion equipment.

It is intended that the processing and materials recovery portion of the facility would incorporate hand-sorting of cardboard, light and heavy iron metals and aluminum cans. It would utilize trommeling — the mechanical separation of material by a rotating cylindrical screen — to remove dirt and glass and would mechanically recover ferrous cans. Additionally, it would employ modular combustion units to burn the remaining organics to provide electricity and/or steam for sale to local utilities and industry.

The recommended selection of modular combustion units would ensure uninterrupted continuity of the City's solid waste management system by providing the necessary flexibility to handle both predictable and unpredictable changes in the waste stream.

The Berkeley City Council, the Solid Waste Management Commission and the Department of Public Works have been working for several years to guarantee that the total Solid Waste Management System for the City will be efficient, environmentally acceptable and economically viable.

In 1972, the Council examined its existing system and concluded that it needed a more environmentally-sound method of refuse disposal. It voted to establish a Solid Waste Management Commission, which was assigned the two-fold task of developing a recommendation for a short-term plan for reducing the quantity of solid waste being generated and a long-term plan for ecologically managing the City's future refuse.

The City has already purchased a 6.3 acre site for the SWMC. The site is on Second Street north of Gilman Street.

Two previous studies have been conducted by the San Francisco firm of Garretson · Elmendorf · Zinov (G·E·Z), Architects and Engineers, and its subsidiary Brown, Vence and Associates (BVA), Energy and Environmental Engineers, to conceptualize the SWMC and to investigate the most appropriate materials and energy recovery technology for the City. Modular combustion has been recommended. An environmental impact report has been prepared by Spectrum Northwest, Social and Environmental Planning Consultants, of San Francisco.

SCOPE OF WORK

The present scope of work was to further assess project feasibility and to develop a conceptual design for the Berkeley SWMC. This included the following tasks:

- Confirmation of markets for recovered materials and energy.
- Analysis of waste stream.
- Assessment of front-end (preprocessing) technology.
- Identification of regulatory agency requirements and environmental constraints.
- Preparation of conceptual design and budget cost estimates for the transfer station/materials and energy recovery facility.
- Development of financing and procurement arrangements.
- Identification of project risks.
- Establishment of an Implementation Masterplan.

REPORT PRESENTATION

The report is presented in two volumes. Volume I contains Chapters 1 through 9, while Volume II contains Appendices A through M.

PROJECT SUMMARY

Markets for Recovered Products

Markets for recovered products — electricity, steam, ferrous and aluminum metals and corrugated boxes — from the proposed materials and energy recovery facility were investigated, along with revenue rates and specifications for each material. Potentially problematic regulatory or contractual areas were also addressed.

Quantity and Composition Analysis

Three distinct waste streams are delivered to the Berkeley Landfill: City-collected refuse, commercial refuse (delivered by haulers which keep monthly accounts with the Berkeley Landfill) and privately-hauled refuse (delivered by private cash-paying customers). Quantity and composition estimates were made of all three waste streams. Composition estimates for City-collected refuse were determined based on the taking of physical samples over one-week periods during the months of December, March, June and September. Composition of commercial and private waste streams were estimated from visual inspections of deliveries to the Berkeley Landfill. To determine quantities, a vehicular weight-scale was installed at the landfill.

Front-End Processing Technology

An examination was made of possible front-end processing technologies available to Berkeley for the purposes of improving refuse combustion, reducing ash production and recovering secondary materials.

Only those technologies found to be compatible with the modular combustion system and Berkeley's waste quantities were analyzed and compared with a base case of mass burning.

Technologies examined included:

- *Size reduction;*
- *Size reduction followed by air classification; and*
- *Trommeling.*

Cost and benefits of the selected front-end process technologies were examined and compared with the mass burning alternative to determine the most suitable approach for Berkeley.

Pollution Control Requirements

The need for project environmental control requirements was assessed with respect to potential air, water, residue and noise pollution. Where requirements were identified, mitigating measures were recommended.

Economic Analysis

Solid Waste Management Alternatives: Economics were analyzed for the following solid waste management alternatives:

- *Transfer and Haul*
- *Transfer and Haul with Mechanical Materials Recovery*
- *Materials and Energy Recovery - Cogeneration (Steam and Electricity)*
- *Materials and Energy Recovery - Electricity Only*

Life Cycle Cost Analysis: The purpose of the life cycle cost analysis was to project costs and revenues of solid waste management alternatives over their useful lives. The net cost of the alternatives can then be computed for each year of project life. A comparison of project net life cycle costs yields the most economically feasible alternative.

A financing computer model developed by the State Solid Waste Management Board was the vehicle used to project the life cycle costs of each scenario under consideration. The model incorporates amortization of capital, product revenues, and levelized debt service. Results are as follows:

Alternative	*Total Life Cycle Costs 1985 Dollars*
Materials and Energy Recovery	
Cogeneration (Class II-1 ash disposal)	*$29,600,000*
Electricity Only (Class II-1 ash disposal)	*$42,200,000*
Cogeneration (Class I ash disposal)	*$58,200,000*
Electricity Only (Class I ash disposal)	*$70,800,000*
Transfer and Haul	
Without Mechanical Materials Separation	*$70,800,000*
With Mechanical Materials Separation	*$76,900,000*

Permit and Approval Requirements

The regulatory constraints on the proposed project are numerous and complex. An identification of all responsible agencies was made along with a brief description of their scopes of authority, permit procedures and approximate times required to obtain each permit/approval, and estimates of preapplication, preconstruction and total permitting time requirements.

Financing, Risks and Procurement

Financing Alternatives: Financing alternatives considered included the following:

- *Public Ownership Options*
  - *Revenue Bonds*
  - *Lease Revenue Bonds.*
  - *Bonds secured by a pledge of taxes*
  - *City's Refuse Disposal Development Fund*
- *Private Ownership Options*
  - *Industrial Development Bonds*
  - *Leveraged Leasing*
- *Federal Funds*

Risks: The following risks were analvzed:

- *Risks of Doing Nothing*
- *Energy Recovery Risks*
  - *Waste Stream Supply*
  - *Energy Markets*
  - *Residual Disposal Facilities*
  - *Facility Construction*
  - *Facility Operation and Management*
  - *Technology*

Procurement: *Two basic procedures for procurement generally used in local government were investigated:*

- *Nonnegotiated Procurement and*
- *Negotiated Procurement*

Five basic practical approaches were analyzed for acquisition of a resource recovery system:

- *Conventional*
- *Turnkey*
- *Full Service*
- *Full Service with Government Ownership*
- *Modified Full Service*

Implementation Strategy

In developing an implementation strategy for the transfer station/materials and energy recovery system, the following desires of the City were considered:

- *Due to the high capital cost and operating complexity of the recommended materials and energy recovey system, the City prefers an experienced full-service contractor to own and operate the system.*
- *The City would like to retain ownership of the transfer station portion of the facility to insure access in case the full-service contractor should default.*

FINDINGS

Markets for Recovered Materials and Energy

- *Markets have been investigated for the purchase of the following recovered energy and materials:*
    - *Electricity - PG&E has agreed to purchase the electricity through a negotiable Power Sales Agreement (PSA).*
    - *Steam - Cal-Ink is a possible steam market. It has hired a consultant to investigate its future steam needs and if SWMC steam use is determined feasible, Cal-Ink will direct a Letter of Interest to the City in late 1980.*
    - *Secondary Materials - A number of previously-contacted firms are willing to bid for the ferrous and aluminum metals and cardboard on a five-year contract with established floor prices or prices pegged to an industrial index.*

Waste Stream Characteristic

- *Refuse sampling studies confirm earlier composition estimates of newsprint, cardboard, aluminum and glass, with slightly less iron metals than expected.*

- *It was found that enough solid waste remains after source separation and recycling to necessitate five 50 TPD modular combustion/boiler units for on-site conversion into a salable energy product.*

Front-End Processing Technology

- *Three appropriate front-end processing technologies were considered worthy of investigation in an attempt to improve refuse combustion, reduce ash production and recover secondary materials. They are:*

  - *Size reduction*

  - *Size reduction followed by air classification*

  - *Trommeling*

Regulatory Agency Requirements and Environmental Constraints

- *Pollution control requirements have been identified:*

  - *Air Quality - The project will require air emission controls. Three potential particulate control technologies capable of meeting the Bay Area Air Quality Management District's (BAAQMD) regulatory limits are:*

    - *Electrostatic Precipitators*
    - *Baghouses*
    - *Dry Scrubbers*

    Best Available Control Technology (BACT) for nitrogen oxides (NO_x) and sulfur dioxide (SO_2) is undefined and, therefore, must be determined by the BAAQMD as soon as possible after selection of a specific modular combustion unit.

  - *Water - No water quality impacts are envisioned other than water to be used for general facility requirements and discharged into the East Bay Municipal Utility District (EBMUD) sanitary sewer system.*

  - *Residues - Process residues will require landfilling. Ash may require landfilling in a Class I hazardous waste site; however, there is a possibility that a Class II-1 or limited-hazardous waste site will be approved, which may mean a cost savings of about one-third.*

  - *Noise - Compliance with all local, state and federal regulations can be achieved.*

- *Permitting time frames have been estimated:*

  - *Preapplication negotiation and review period - One month. (Preapplication negotiations with the BAAQMD will take much longer.)*

  - *Preconstruction permitting process - **9 to 33** months.*

  - *Remaining permitting period during final construction and initial project startup - **2 to 3** months.*

Preliminary Design and Budget Cost Estimates for the Transfer Station/Materials and Energy Recovery Facility

- *Owning and operating costs for materials and energy recovery over a 20-year period are estimated to be about half those for the transfer and haul alternatives, assuming Class II-1 disposal of ash.*

- *If Class I disposal of ash is required and utilized, then the estimated savings between materials and energy recovery alternatives and transfer and haul alternatives is reduced.*

- *At Class I disposal costs, other alternatives for ash disposal become attractive. One alternative which was investigated was to convert the ash into concrete-like slurry, from which a multitude of useful products could be formed. Though this process has been demonstrated on a laboratory scale only, cost appears to be about 60% of the transfer and haul costs to a Class I landfill.*

- *The 1984 capital costs for the transfer station are estimated in the \$5-\$6 million range.*

- *The 1984 capital costs for the materials and energy recovery facility are estimated in the \$28-\$30 million range.*

Financing and Procurement Arrangements

- *A variety of financing and procurement arrangements exist consisting of any combination of public/private involvement. Monies are available in the City's Refuse Disposal Development Fund for funding portions of the proposed facilities. Federal funds also exist for construction purposes.*

- *Should the proposed facilities be constructed at the same time (instead of in a phased development) the expressed desire to divide the ownership of the SWMC creates certain difficulties which must be resolved prior to securing long-term financing:*

  - *Definition of physical boundaries of the transfer station and energy recovery portions of the SWMC to ensure proper allocation of costs;*

  - *Allocation of SWMC equipment costs serving both the transfer station and resource recovery portions;*

- *Selling or leasing the land on which the resource recovery system will be located in order to achieve private ownership;*

- *Determination of the manner in which the SWMC will be assessed for taxes;*

- *Development of an insurance program for the SWMC which protects both portions from damage to the other; and*

- *Development of a procurement procedure accomodating public bidding and full-service contractor "designer's preferences".*

While none of the issues is insurmountable, additional work is required to permit early resolution.

Project Risks

Project risks have been identified and can be allocated to various project participants.

- *Risks of Doing Nothing*

  - *If the City elects not to implement a transfer or materials and energy recovery system, City collection vehicles will be required to travel greater distances for refuse disposal after the City landfill closes. Because the City's collection fleet is old and not designed for this type of operation, excessive equipment maintenance and downtime can be anticipated.*

- *Materials and Energy Recovery Risks -*

  - *Waste Stream Supply: The City controls through its municipal collection service only 30% of the refuse currently disposed at the Berkeley Landfill. Should the City implement a materials and energy recovery project designed on the full landfill tonnage, the City runs the risks of opening the doors to the facility and finding the only waste delivered is the City-collected refuse.*

  - *Energy Markets: The commitment of Cal-Ink to purchase steam from the project is still questionable. Should Cal-Ink wish to participate, their financial stability and future plans represent another risk.*

  - *Disposal Facilities: Of the risks that will impact the costs of the proposed project, one of the greatest is associated with the disposal of ash. Dependency upon outside-county landfills runs the risk of importation bans and excessive disposal fees.*

  - *Facility Construction: Delays can result in greatly increased construction costs. Various risks are associated with project financing such as fluctuating interest rates or simply the difficulty in meeting financial requirements. Changes in laws and regulations could also occur that could increase costs and*

delay the project. Once the facility is fully constructed, it may be unable to meet performance specifications. Should private industry be asked to construct and/or operate the proposed facility, the City could lose access to the transfer station portion of the facility, thereby requiring City collection vehicles to long-haul refuse to the nearest landfill if for any reason the contractor should default.

- *Facility Operation and Management: O&M costs could be higher than projected. Quality and quantity of products could be different than expected.*

- *Technical Risks: Key among these is the generation of electricity via superheated steam. Emission control also raises some risk consideration. The dry scrubber which is being proposed for particulate control has yet to be tested on emissions from a solid waste facility. Trommeling as a front-end process is also being proposed. While trommeling has been demonstrated, the trommel as conceptualized is required to make a three-way separation of the refuse. Only a two-way separation has been demonstrated.*

RECOMMENDATIONS

- *The City should proceed with a three-phased construction schedule for the SWMC as conceived in this report beginning with the implementation of the recycling center, first; the transfer station, second; and the materials and energy recovery facility, third.*

- *The recommended transfer station utilizes a receiving floor where refuse is deposited and from which long-haul transfer-trailer rigs haul wastes to the closest available landfill.*

- *The materials and energy recovery facility recommended incorporates modular combustion units capable of producing a high temperature and pressure steam for sale to local industry and/or efficient electrical production for use by the City operations or sale to PG&E. Trommeling should precede modular combustion in an effort to improve combustion, reduce ash production and recover secondary materials. To control emissions from the combustion units, a dry scrubber is recommended.*

- *The City should go ahead with the building of the transfer station by hiring an architectural/engineering consultant and bidding out the construction, materials and equipment.*

- *To facilitate divided ownership of the SWMC, the City should pursue the Implementation Strategy outlined below encompassing both financing, procurement and risk allocation:*

- *Financing*

  - *Utilization of the City's Refuse Disposal and Development Fund for financing the capital cost of the transfer station portion; O&M costs could be paid from homeowner collection rates and private-hauler tipping fees.*

  - *Utilization of industrial development bonds issued by the California Pollution Control Financing Authority (CPCFA) for ownership of the resource recovery portion by a full-service contractor; the contractor's payments could be paid from tipping fees and materials and energy sales.*

- *Procurement*

  - *The recommended procurement of the transfer station portion is the Conventional Approach with an A/E firm.*

  - *Recommended procurement of the materials and energy recovery portion is the Modified Full Service Approach pursuing the following steps:*

    - *Selection of a qualified Consultant Team to assist the City in all remaining aspects of project development.*

    - *Prequalification of prospective private-industry proposers providing full service.*

    - *Selection of a full-service contractor.*

    - *Negotiation of contracts between the City, the Consultant Team and selected proposers and between the City, the Consultant Team and other local resource recovery projects.*

    - *Negotiation and finalization of all required residual disposal and market contracts by the City and Consultant Team.*

    - *Securement of all required permits by the City and Consultant Team.*

    - *Construction.*

- Shakedown.
- Startup.

- If implementation goes according to schedule, startup should occur in 1985.

- Risk Allocation

  To minimize risks discussed previously, the City should:

  - Own the transfer station portion of the facility to reduce the risk of contractor default.
  - Select a full-service contractor with responsibilities for financing, construction and operation of the materials and energy recovery portion of the SWMC, including meeting all terms and conditions of contracts. The City may be required to minimize private industry's risks by such methods as guaranteeing a set revenue for the operation of the facility by the private operator.
  - Continue to develop a relationship with Cal-Ink and PG&E and participate in negotiations between the contractor and the markets.
  - Begin discussions with landfill operators to establish preliminary terms and conditions and participate in long-term negotiations.
  - Aggressively pursue regulatory agency permission of Class II-1 disposal.

- Further development of the SWMC should include the following steps:

  - Continuation of present management activities as needed.
  - Continuation of the public participation program conducted during the present phase.
  - Continuation of the monitoring of waste quantities and compositions.
  - Securement of ash disposal agreements from regulatory agencies and site operators to allow ash disposal in a Class II-1 site.
  - Performance of periodic design and construction reviews to ensure satisfaction of all City requirements.

CHAPTER 2

MARKETS FOR RECOVERED PRODUCTS

INTRODUCTION

This chapter focuses on the markets for recovered products from the proposed resource recovery facility. The discussion includes market identification, revenue rates and specifications associated with each material. Potentially problematic regulatory or contractual areas are addressed and copies of pertinent correspondence are included. An inventory of the project's potential steam markets is presented in Table 2-1; the steam demands of the interested firms are detailed in Table 2-2.

ELECTRICITY

The potential purchaser of electrical power produced at the facility is Pacific Gas and Electric Company (PG&E). The Federal Public Utilities Regulatory Policies Act of 1978 (PURPA), Section 210, encourages the production of energy through cogeneration and other alternative technologies including resource recovery. These regulations require electric utilities to purchase electric power from, and sell electric power to, qualifying cogeneration and small power production facilities. It is expected that the proposed facility will meet the qualification specifications.

In regard to PURPA, regulations promulgated by the Federal Energy Regulatory Commission (FERC) (Reference 1) require utilities to purchase cogenerated power at the rate of their avoided cost. The avoided or marginal cost is the expense necessary to produce a new, additional unit of power, i.e., kilowatt-hour of electricity (KWH). This is in contrast to an average or wholesale cost, which is based on earlier, and usually lower, costs of production.

In December of 1979, at the conclusion of an investigation into public utility purchase of cogenerated power, the California Public Utilities Commission (PUC) issued OII-26, a decision integrally related to the FERC regulations and the development of cogenerated power in California. Citing PG&E's efforts in this area as inadequate, the PUC directed the utility to further encourage, among other services, the development of municipal cogenerated power. OII-26 authorizes PG&E to purchase such power at rates equaling its marginal cost of electricity and to provide supplementary power to cogenerators at standard tariff rates.

In response to the requirements of OII-26, PG&E has developed a Power Sales Agreement (PSA) detailing its purchase terms and conditions, marginal cost data and proposed purchase prices for cogenerated and other alternative sources of power. PG&E's marginal cost and, therefore, its required purchase price has been developed on the basis of separate energy and capacity payments. The energy payment is based on the avoided incremental cost of fuel necessary to produce a new unit of power. In 1980 dollars, the energy payment price rate is approximately $0.053 per kilowatt-hour (KWH). The capacity payment is based upon a contractual agreement to provide firm power during a specified period of time. While shorter term contracts provide greater flexibility, higher payments are made for longer periods of delivery. Heavy penalties are incurred, however, if the facility fails to provide contracted power. Assuming a standard twenty-year agreement, the capacity payment price is approximately $.009 per Kwh.

An analysis of PG&E's Power Sales Agreement by the firm of Orrick, Herrington, Rowley and Sutcliffe (OHRS) identifies the following issues which may preclude compliance with the requirements of the PUC and FERC rulings.

- *By basing energy prices on the prior quarter's price of oil, the price paid would appear to be less than current marginal costs as required by the PUC and FERC actions.*

- *The PSA allows the seller to fix "capacity" payments for the term of the contract, but allows "energy" payments to "float" with the price of fuel. If the marginal cost of new capacity increases substantially over the period of the contract, this fixed-price approach could be disadvantageous.*

- *The penalties for failure to deliver energy or capacity appear to go beyond that allowed or required by the PUC and FERC rulings.*

- *The provisions of the PSA regarding curtailment of power purchases appear to go beyond those contemplated by the PUC and FERC.*

- *The interconnected costs to be borne by the seller under the PSA go beyond those permitted by the FERC regulations.*

- *For additional reasons, the energy and capacity payments in the PSA may fall short of PG&E's marginal costs.*

Details and discussions of these points can be found in the OHRS report which is located, with PG&E's Power Sales Agreement, in Appendix D.

In a meeting with PG&E's representatives, a preference was indicated for the purchase of electricity. Purchase of steam is a second-level preference, requiring steam price negotiations and adjustments for the risk of project investments. The risks to be considered include the security of contracts for input fuel supply, the composition of MSW over the project life, facility storage capacities and the use of an alternative fuel.

PG&E considered suggestions of a payment exceeding the marginal cost rate, sharing short-term deficit in anticipation of a lower future escalation rate. While the PUC ruling is not specific on this point, FERC regulations clearly delineate the marginal cost rate as the maximum allowable payment, as specified in Section 210 of PURPA, thus making this possibility extremely unlikely. In the event that FERC decides to allow state agencies greater latitude in the administration of regulations, it is possible that a subsequent PUC ruling might allow such payments.

While PG&E is committed to purchasing a certain quantity of capacity from alternative energy sources, the company is not willing to make up front capacity payments as this would place PG&E in a position of assuming the risk of product availability. It should be noted, however, that despite the potentially disadvantageous nature of the currently described capacity payments, such contracts will be limited in the future. Should a project delay signing capacity contracts until product availability is firmly ascertained, PG&E may have fulfilled its capacity requirements by that time.

According to the PSA, power purchase curtailment may occur at those times when PG&E can produce power at a lower rate than the cost of purchased power units. While the PSA compliance with the FERC regulations in this area is questionable, it is possible that such curtailment periods could reach 600 hours per year. PG&E has indicated this occurs primarily during late spring when hydropower becomes available. The company has suggested that cogeneration facilities could advantageously perform heavy maintenance during this time. A more detailed discussion of this topic appears in the OHRS report in Appendix D.

PG&E has reviewed the proposed project's plans and specifications. The company's comments are included in Appendix D.

In accordance with OII-26, the purchasing utility is required to assist the project proponent in securing appropriate environmental permits. While the PSA does not address this issue, PG&E has indicated that it, or a contracted consulting firm, will provide such assistance on a limited basis.

In regard to electricity market agreements, PG&E would prefer agreements be signed with the facility owner. PG&E has written a letter of interest to purchase cogenerated energy according to the terms of PSA. This letter appears in Appendix D.

In the consideration of PG&E's Power Sales Agreement, it is important to note that the PUC has given only preliminary approval of the terms described therein. Written comments on the PSA are currently being solicited.

The PSA is an official offer to purchase electricity and, therefore, is a place to begin negotiations. Prior to negotiations, the PSA should be redrafted with respect to the concerns expressed by Orrick, Herrington, Rowley and Sutcliffe and then resubmitted to PG&E. Final contractual agreements should designate what facilities are to be provided and specific equipment ownership.

As an alternative to selling power to PG&E, the City is investigating the option of having PG&E (for a charge) wheeled the power to City operations such as street lighting and traffic signals. City operations currently pay approximately $0.06 per Kwh.

STEAM

Steam market identification began with a list from the California Department of Industrial Relations of all licensed industrial boilers within a serviceable radius of the project's Gilman Street site. For the purpose of the study, minor industrial operations such as dry cleaning stores were culled from the list. The remaining facilities formed the market survey group, which is presented in Table 2-1.

An industrial operations and steam energy questionnaire was sent to all organizations comprising the market study group. The survey form appears in Appendix E. Information was elicited on the firms' histories and production capacities, current types of fuel, operations and steam load characteristics.

Subsequent to the distribution of questionnaires, all members of the market survey group were invited to attend an informational meeting on the proposed project. Representatives of G·E·Z/BVA and the City of Berkeley presented project plans and answered the firms' questions primarily regarding steam conditions and sales. Particular attention was directed at determining the firms' conditions for signing long-term purchase agreements.

Organizations surveyed but not in attendance at the informational meeting were contacted by phone to answer questions and elicit information on steam load and conditions requirements. From these efforts, businesses with a firm interest in the purchase of steam were determined; the companies and pertinent plant information are presented in Table 2-2.

Table 2-1

STEAM MARKET SURVEY GROUP

FACILITY	LOCATION	FACILITY	LOCATION
McDermott Meat	1120 - 2nd Street Berkeley CA 94710	Tinsley Laboratories, Inc.	6th Street & Dwight Way Berkeley CA 94710
Far Best Corporation	640 Gilman Street Berkeley CA 94710	Macaulay Foundry Co.	811 Carleton Street Berkeley CA 94710
Cal-Ink	1404 - 4th Street Berkeley CA 94710	Pacific Steel Casting Co.	1333 - 2nd Street Berkeley CA 94710
Manasse Block Tanning	1300 - 4th Street Berkeley CA 94710	SKS Die Casting Co.	2200 - 4th Street Berkeley CA 94710
DeSoto, Inc.	4th and Cedar Streets Berkeley CA 94710	Gateview McKinley Towers Neighborhood Council	555 Pierce Albany CA 94706
U.S. Department of Agriculture	800 Buchanan Street Berkeley CA 94710	National Starch & Chemical Corp.	742 Grayson Berkeley CA 94710
Cutter Laboratories	4th and Parker Streets Berkeley CA 94710	Berkeley Forge & Tool	1331 Eastshore Highway Berkeley CA 94710
Colgate-Palmolive Company	2700 - 7th Street Berkeley CA 94710	Williams & Lane, Inc.	1077 Eastshore Highway Berkeley CA 94710
Cetus Corporation	600 Bancroft Way Berkeley CA 94710	Tuttle Manufacturing Co.	4th & Gilman Streets Berkeley CA 94710
Kennerly-Spratling, Inc.	1456 - 4th Street Berkeley CA 94710	Spenger's Fish Grotto	1919 - 4th Street Berkeley CA 94710
A&B Die Casting	1417 - 4th Street Berkeley CA 94710		

Table 2-2

BERKELEY STEAM MARKET SUMMARY

Market	How Long in Business	Shifts	Operating Days/Week	Steam Demand (lbs./hr.) Average Hourly	Maximum	Minimum	Willing to Enter Long Term Contract	Price of Steam	Info. Needed to Sign Letter of Intent to Purchase	Comments
BERKELEY FORGE & TOOL Contact: Stanton Bierwith President 526-5034	30	1	5	--	12,000 353° F 140 psig	0	Yes	Actual pounds used	Hookup costs; cost per pound; date available	· Looking at 2 shifts · Fluxuating demand · Currently use natural gas · Considering electrically operated air compressors
CAL INK Contact: Michael Ferguson Plant Manager 525-1188	79	3	5	14,000	18,000 150 psig	10,000 -- --	No	Competitive with firm's production costs	Cost; delivery date; amount available; cost of conversion	· Currently use natural gas Diesel (standby)
COLGATE-PALMOLIVE Contact: Wallis Curtis 845-1500	63	1*	5	45,000 30,000** 15,000***	65,000 300° F 140 psig	35,000 -- --	?	?	Cost	· Currently use natural gas Diesel (standby) · Price of stm.(12-31-79)$4.00/1000# · Mutual Agreement - Steam purchase for garbage collection (2400 tons/year - 65% combustible)
DESOTO Contact: K. P. Flaks 526-1525	54	1	5	1,800	-- 300° F 150 psig	-- -- --	--	--	--	· In process of reactivating resin plant which is their prime user of steam · Currently use natural gas
FAR BEST Contact: Robert McDonough Plant Manager 525-2534	47	1	5	880	1,430 4 hrs./day 100-150 psig	330 4 hrs./day 100-150 psig	Maybe	Costs	Price of steam; pipeline installation costs; dependability of steam; transferability of contract	· Currently use natural gas
MANASSE BLOCK Contact: G. F. Oulton Vice President 525-8648	79	1	5	2,200	-- -- 80 psig	-- -- --	No	--	--	· Currently use natural gas Diesel (standby) · Not interested
USDA Contact: Paul Gustafson Facilities Engineer 486-3461	37	1.5	5	3,300 13 hrs/day 125 psig	3,300 13 hrs./day 125 psig	660 11 hrs./day 25 psig	?	Production cost	--	· Long term contract would need approval from Washington · Currently use natural gas Diesel (standby)

* sometimes 3 shifts
** swing shift
*** graveyard shift

It was determined from the compiled information that the two most attractive markets for the project are the Cal-Ink and Colgate-Palmolive companies. The location of the Colgate-Palmolive facility, however, approximately two miles distant from the proposed site, effectively precludes its consideration as a steam market due to design and cost factors, thus, the sole viable steam market for the project is Cal-Ink.

The Cal-Ink facility uses steam for industrial processing. The plant operates on a three shift, 24-hour basis with some variation in hourly steam load demands, as presented in Table 2-3. There is minimal seasonal variation in demand. Natural gas is currently used for steam generation; steam conditions are 350°F and 150 psig. Cal-Ink is planning an engineering study and review of its present steam generation plant and is currently considering an expansion of production capacity. It is estimated that energy consumption will increase approximately ten percent in the next ten to twenty years.

Cal-Ink has expressed an interest in the alternative of purchased steam from the proposed facility. Consideration of such an alternative is dependent on steam price, quantity and availability of steam, anticipated delivery date and cost conversion factors. Letters of interest from Cal-Ink are located in Appendix E.

The steam price range for which Cal-Ink's interest was solicited is $5.50 to $7.50 per 1,000 pounds, FOB its facility. Factors in the formulation of this price range include the replacement cost of fuel and the cogeneration break-even point, the point where cogeneration is more cost-effective than selling only electricity. The price range allows for variable amortization periods. Cal-Ink, as the project steam market, has expressed interest only in a short-term contract, thus indicating that a higher price for steam and shorter amortization period would be necessary for the project.

Table 2-3

HOURLY STEAM DEMAND OF CAL-INK

HOUR*a	DEMAND*b	HOUR*a	DEMAND*b	HOUR*a	DEMAND*b
1	15,000	9	17,000	17	15,000
2	15,000	10	18,000	18	15,000
3	15,000	11	16,000	19	15,000
4	15,000	12	17,000	20	15,000
5	15,000	13	17,000	21	15,000
6	15,000	14	15,000	22	15,000
7	15,000	15	15,000	23	15,000
8	16,000	16	15,000	24	15,000

*a beginning hour is 1:00 AM
*b demand in lbs/hr, 150 psig at 350°F.

SECONDARY MATERIALS

In an economic climate of high inflation and diminishing natural resource reserves, the recovery and marketing of secondary materials is both environmentally sound and economically viable. The purpose of this section is to provide current market conditions and to anticipate projected revenues. Extensive background information for this section is located in the Phase One report of this study (Reference 2) and further work by BVA's materials markets consultant, Mr. Terry Harrison, whose full report appears as Appendix F.

Those firms which had indicated interest in purchasing recovered material during early phases of the project were contacted again to determine their continued interest. Each firm was sent a standard form "Indication of Intention To Bid for Resource Materials" which requested the following information: current prices, floor price for a five-year contract and indication of intent to bid on a firm contract. Contract terms were delineated as FOB the Berkeley facility. Telephone calls were made to elicit information from those firms not responding to the survey. Information gathered indicates that excellent markets still exist for each of the materials and that prices generally are higher now than in 1977. This section summarizes information for corrugated boxes, ferrous and aluminum materials.

Ferrous Metal

The majority of ferrous scrap in MSW consists of ferrous cans. Markets for these cans and other ferrous scrap encompass chemical processing and remelt applications. The market for ferrous scrap metal is relatively weaker than for the other two principal secondary materials - aluminum and corrugated boxes. This is due, in part, to depressions in the domestic copper mining and steel industries, major utilizers of ferrous scrap. Strong export demand, however, somewhat counter balances this condition. The different grades of ferrous scrap will require distinct marketing strategies.

The ferrous cans fraction of the waste stream is proposed to be mechanically separated by a trommel and magnetic separator (refer to Chapter 6). This fraction consists largely of tin-plated steel food cans. The degree of contamination, and the presence of lead, aluminum and other metals in the fraction influences the market price. It is reasonable, however, to project revenues based on a price of $30 per ton, FOB the proposed facility.

Light ferrous scrap, which includes sheet metal and white goods, is manually separated on the receiving floor. These materials could alternatively be marketed alone or possibly in combination with the ferrous can fraction. The marketing strategy for this particular grade is dependent upon the ultimate buyer, as companies differ in specifications for acceptable scrap. A price of $30 per ton, FOB the proposed facility, is anticipated.

The heavy ferrous fraction consists of structural steel and other cast material; it is also manually separated from the waste stream. This fraction can be marketed in two grades - Number 2 Heavy Metal Scrap (HMS) and Cast. A price of $70 per ton, FOB the proposed facility, has been determined for this fraction.

Aluminum

Due, in part, to the high energy savings obtained from the recycling of aluminum scrap, the market for this material is strong and is expected to continue. This is a well-established industry with high popular acceptance and support. Recyclable aluminum scrap from the proposed facility will consist primarily of cans. The potential market for

this fraction is the Recycling Center, which will also be located on the SWMC site. Specifications for aluminum cans differ among buyers; however, a minimally acceptable density must be achieved, primarily for shipment considerations. This process requires a shredder, which the Recycling Center is planning to acquire. Revenue projections for this fraction are based on a price of $425 per ton nonshredded, FOB the Berkeley facility.

<u>Corrugated Boxes</u>

The market for wastepaper, including corrugated boxes and loose cardboard, is subject to cyclical variations following the fluctuations of the economy. Prices generally decrease with a downturn in the economy and rebound sharply as inventories are reduced. The current and somewhat unusual shortage of pulp has created a particularly strong market for wastepaper. A strong export market demand supports the current price of $50 per ton, FOB the Berkeley facility, for corrugated boxes. Loose cardboard is currently priced at $36 per ton, FOB the facility. The proposed market for all the corrugated and cardboard paper is the Berkeley Recycling Center, which will have the paper baler required for the processing of corrugated boxes and cardboard. Care must be exercised in minimizing contamination levels; allowable levels are 1% for plastic bags and other contaminants and 5% for outthrows such as magazines and newspapers.

CHAPTER 3

QUANTITY AND COMPOSITION ANALYSIS

REFUSE COMPOSITION ANALYSIS

Introduction

This section describes the methodology and results of the refuse composition analysis at the City of Berkeley Landfill. The procedure outlined below utilizes methods developed by SCS Engineers for the State Solid Waste Management Board (Reference 3). The objective is to determine the composition of the refuse to be received at the proposed resource recovery facility.

Planning

Three distinct waste streams are delivered to the Berkeley Landfill: city-collected refuse, commercial refuse (delivered by haulers which keep monthly accounts with the Berkeley Landfill) and privately-hauled refuse (delivered by private cash-paying customers). The majority of the survey effort focused on city-collected refuse for the following reasons: 1) any waste processing facility built for Berkeley will certainly handle this stream; and 2) SCS study data are directly comparable to a survey of this stream only.

City-Collected Refuse

The initial phase of the task involved a qualitative evaluation of the waste shed in the survey. The preliminary evaluation included:

- *Identification of the subject waste shed and geographical delineation of its boundaries (see Figure 3-1).*
- *Characterization of the collection and disposal system.*
- *Establishment of communication with the appropriate city department.*

Survey Plan Development: Both sample size (weight) and sample number are important considerations in composition analysis. Research conducted by SCS has determined that manual sorting of 200 to 300-pound (approximately two loose cubic yards) samples is an efficient method for waste composition estimation.

The number of samples needed for 90% confidence was also determined by SCS. This number varies with the component being measured, as shown in Table 3-1. Using this table, it was decided a priori to sort a minimum of 47 samples per week. One-week sampling periods were scheduled for December 10-14, 1979; March 24-28, 1980; June 16-20, 1980; and September 29-October 3, 1980. Sampling was conducted over these four periods to investigate the seasonal variation of the waste stream.

Figure 3-1 displays the collection schedule for City crews. Each day different socio-economic segments of the City receive collection. On Monday the hills are serviced and by Friday the flatlands are receiving service. It was, therefore, possible to select loads at random each day and assure that no major segment of the city was omitted from the study.

A variety of methods are available for obtaining a 200 to 300-pound sample from a truckload. For this survey, a random sample which represented the load was selected.

Figure 3 - 1

Berkeley Refuse Collection Zones

1 = Monday
2 = Tuesday
3 = Wednesday
4 = Thursday
5 = Friday

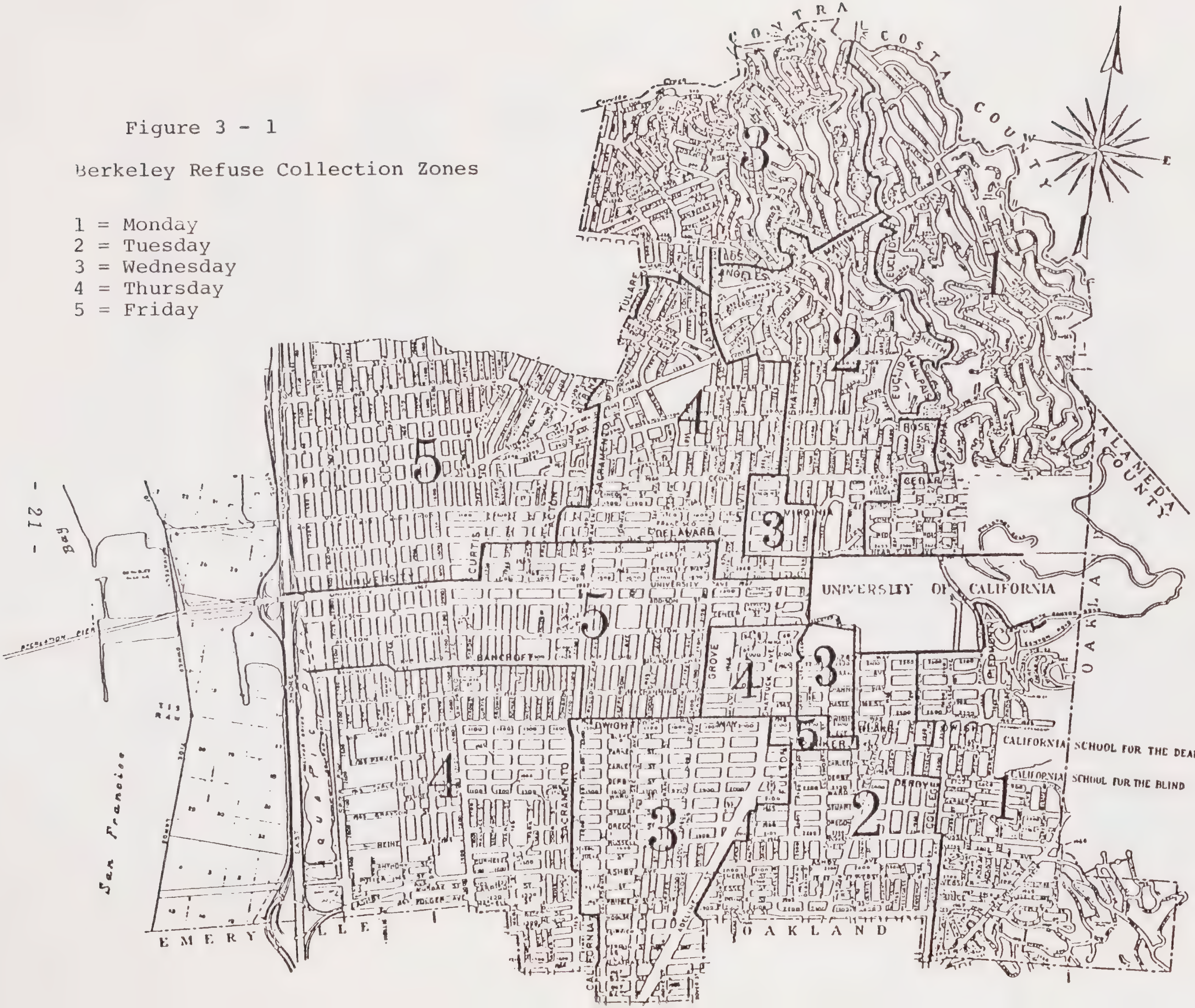


Table 3-1

*NUMBER OF SAMPLES REQUIRED FOR 90% CONFIDENCE**

MATERIAL	NO. OF SAMPLES
Newspaper	37
Corrugated	12
Ferrous	37
Nonferrous	452
Glass	47

* Reference 3-1

Survey Procedure: The basic equipment requirements are shown in Table 3-2. A vehicle load discharge area was prepared for use in the survey. Adjacent was a sorting area upon which tarpaulins were placed for sorting. The sorting crew consisted of five to seven people who manually sorted the samples, with one or two professional staff overseeing the operation. Sample components were placed in identified containers according to categories listed in Table 3-3.

The procedure for each sample was to direct the refuse vehicle to a cleared location where the load was dumped. The randomly-selected portion of the load was then placed in the sampling bin. The bin was weighed with tare and net weights noted on the data sheet.

The sample was then deposited on the tarpaulins for sorting. After each sample was sorted, all component containers were weighed, logged on the data sheets and then emptied in preparation for the next sample.

The results of the survey were recorded, with no adjustments made for moisture. The waste samples represented solid waste as it would be received from city collection vehicles at a resource recovery facility.

Survey Results: Composition survey results are shown in Table 3-4. Components are grouped for ease of comparison with the 1978 SCS study. In particular, the grouping of "miscellaneous inerts" and "other nonferrous" under "organics" was done to duplicate SCS methods. (These components are also shown separately to indicate their contribution to ash or residue from a waste-processing system.) To aid in comparison, Table 3-5 shows composition for Berkeley (as determined in this study) and SCS data for Davis Street (Oakland refuse) and Mountain View (San Francisco refuse) landfills.

Precision of the Berkeley results is quantified in Table 3-6. Using Student's t-statistic (Reference 4), a range of precision for each average was calculated at the 90% confidence level. For example, in the December survey, the average measured percentage of mixed paper was 34.8%; there is a 90% chance that the true percentage lies between 32.9% and 36.7%.

For individual components, the results confirm earlier estimates in the Phase One study (Reference 2) for newsprint, cardboard, aluminum and glass, with slightly less steel than expected. A great deal of mixed paper was found; "yard" waste and "miscellaneous" categories, consequently, were smaller than the Phase One study estimates.

Seasonal variation is evident in several of the categories shown in Table 3-6. While the December and June samples are alike in most respects, the March sample shows less mixed paper, newsprint and yard waste, and more miscellaneous organics and corrugated. Most target materials for recycling (ferrous, aluminum, glass) maintain similar concentrations through December, March and June. The effects of a recent increase in curbside collection of recyclables appears in the September sampling with a drop in glass and ferrous content. The September rise in rubber, wood and leather may be attributed to three samples containing an unusually high amount of wood; note that the range of precision has also increased reflecting greater variation among September samples for this component.

Laboratory Analysis: Once during each sampling week, a composite sample, containing the proportions of refuse components found in Monday through Wednesday's sorting, was taken for laboratory analysis in sealed plastic bags. Heating values for the December and March sorting periods were 8,327 and 8,672 BTU/lb., respectively (dry basis).

Moisture contents were 42.50% and 18.48%, respectively. No correlation was found between moisture and rainfall. For each of the combustible components, individual ultimate analyses were performed in the laboratory. Those results are shown in Table 3-7. Inert components were considered to be 100% ash.

Table 3-2

BASIC EQUIPMENT REQUIREMENTS

- *Protective clothing for laborers, i.e., rubber gloves, hats, masks and eye protection*
- *Waste-handling equipment such as shovels, pitch-forks and rakes*
- *Portable scales*
- *Sampling facilities, e.g., plastic tarpaulins*
- *Bins and plastic containers*
- *Data collection equipment*

Table 3-3

COMPOSITION SURVEY - SORTING CATEGORIES

·*Newsprint**
·*Corrugated**
·*Other paper**

·*Rubber, wood, textiles, etc.**
·*Plastic**

·*Yard Waste**
·*Miscellaneous Organics, Food Wastes**

·*Ferrous*

·*Glass*

·*Aluminum*

·*Other nonferrous*

·*Miscellaneous inerts, fines*

* *Represents components separately analyzed in the laboratory.*

Table 3-4

SOLID WASTE COMPOSITION ESTIMATES*

ESTIMATED COMPOSITION (% by weight)

	December 1979		March 1980		June 1980		September 1980		Average	
"Organics"		54.7		55.2		50.8		59.4		55.0
Mixed Paper	34.8		28.2		34.5		33.9		32.8	
Rubber, Wood, Leather	2.8		3.0		4.8		6.4		4.3	
Miscellaneous Organics	10.0		21.0		9.2		16.4		14.1	
Miscellaneous Inerts	6.7		2.8		2.3		2.7		3.6	
Other Nonferrous	0.4		0.2		0.1		0.0		0.2	
Ferrous		3.8		3.7		3.6		2.4		3.4
Aluminum		0.8		1.0		0.5		0.9		0.8
Glass		10.1		12.2		8.5		7.2		9.5
Corrugated		4.8		9.6		6.6		9.4		7.6
Newsprint		9.7		7.2		13.0		8.7		9.7
Plastic		6.1		6.1		8.9		3.9		6.3
Yard		10.0		10.0		7.5		8.2		7.7
										100.0

* Components are grouped for ease of comparison with SCS report (Reference 3-1).

Table 3-5

COMPARISON OF BERKELEY COMPOSITION
(% by weight)

	BERKELEY				DAVIS STREET (Oakland refuse)			MOUNTAIN VIEW (San Francisco refuse)		
	Dec '79	Mar '80	Jun '80	Sep '80	Sep '77	Nov '77	Feb '78	Sep '77	Nov '77	Mar '78
Organics	54.7	55.2	50.8	59.4	64.4	63.2	51.3	76.2	61.6	64.4
Ferrous	3.8	3.7	3.6	2.4	4.7	5.0	4.8	2.9	4.9	4.4
Aluminum	0.8	1.0	0.5	0.9	0.8	0.8	1.3	0.5	1.3	0.9
Glass	10.1	12.2	8.5	7.2	7.0	6.2	8.3	4.9	7.6	5.4
Corrugated	4.8	9.6	6.6	9.4	6.2	4.6	6.7	7.8	10.9	8.1
Newsprint	9.7	7.2	13.0	8.7	7.6	9.4	11.7	5.7	9.7	7.1
Plastic	6.1	6.1	8.9	3.9	2.9	4.7	6.3	2.1	4.3	9.1
Yard	10.0	5.1	7.5	8.2	5.8	5.8	9.5	N/A	N/A	0.3

Table 3-6

COMPOSITION RESULTS: MEAN VALUES & RANGE OF PRECISION (90% CONFIDENCE)
(% by weight)

	DECEMBER N = 32	MARCH N = 50	JUNE N = 50	SEPTEMBER N = 43
Mixed Paper	34.8 ± 1.9	28.2 ± 3.0	34.5 ± 2.6	33.9 ± 3.9
Rubber, Wood, Leather	2.8 ± 0.5	3.0 ± 1.0	4.8 ± 1.2	6.4 ± 2.1
Miscellaneous Organics (Food, etc.)	10.0 ± 0.5	21.0 ± 3.0	9.2 ± 1.8	16.4 ± 3.5
Miscellaneous Inerts	6.7 ± 0.3	2.8 ± 0.8	2.3 ± 0.5	2.7 ± 0.5
Other Nonferrous	0.4 ± 0.1	0.2 ± 0.2	0.1 ± 0.1	0.0 ± 0.0
Ferrous	3.8 ± 0.6	3.7 ± 0.9	3.6 ± 0.5	2.4 ± 0.5
Aluminum	0.8 ± 0.1	1.0 ± 0.7	0.5 ± 0.1	0.9 ± 0.2
Glass	10.1 ± 1.4	12.2 ± 2.1	8.5 ± 1.1	7.2 ± 1.0
Corrugated	4.8 ± 1.4	9.6 ± 2.6	6.6 ± 1.5	9.4 ± 2.0
Newsprint	9.7 ± 1.8	7.2 ± 1.51	13.0 ± 1.8	8.7 ± 1.4
Plastic	6.1 ± 1.1	6.1 ± 1.1	8.9 ± 0.7	3.9 ± 0.6
Yard	10.0 ± 0.5	5.1 ± 1.7	7.5 ± 2.0	8.2 ± 2.6

Using the relative proportions of components shown in Table 3-4, it is possible to form a weighted average ultimate analysis for a composite sample for four sampling periods and for all four sampling periods combined. Table 3-8 presents these calculated analyses. The ash value is of particular interest for this study.

Spectrographic analyses of organic refuse components and ash are presented in Table 3-9 and 3-10.

The analyses shown in Table 3-7 and 3-8 are not directly comparable with results of the SCS study. Heating value and moisture are reported by SCS for the combined organic fraction of surveyed waste; this study reports heating value and moisture for a composite sample of the waste including nonorganic and organic components.

The heat values found in this study are comparable with the results of similar studies. Moisture contents are also within reported values. Carbon, oxygen and hydrogen are the predominant elements. In the composite samples, low concentrations of chlorine and sulfur are found; and it is clear from the component samples (Table 3-8) that plastic is the major contributor to both.

Spectrographic analyses show silicon and potassium as principal constituents of the ash; it may be inferred that glass and minerals comprise most of the ash from combusted waste with 100% burnout. Small but significant amounts of titanium and chromium may indicate pigments and clays from paint and paper.

For the laboratory analyses, sample size and number have been sufficient to identify any wide divergence from commonly accepted values for moisture, heating value and ash. No such divergence has been found. A much larger number of samples would be needed to obtain results with precision of $\pm 10\%$. The necessary number of samples can only be found by repeated sampling and analysis, but a minimum of 20 to 30 samples would be needed.

Commercial and Private Composition

Composition of commercial and private waste streams presented in Table 3-11 has been estimated from visual inspection of deliveries to the Berkeley Landfill. It should be emphasized that because the waste streams represent 70% of the waste currently accepted at the landfill (refer to Table 3-16), their composition must be more accurately determined prior to final design of the Berkeley facility's waste-processing system.

Table 3-7

COMPONENT SAMPLES - PROXIMATE & ULTIMATE ANALYSES

	Cardboard	Newsprint	Yard	Rubber, Wood, etc.	Plastic	Mixed Paper	Miscellaneous Organics
Moisture Content (% by weight)	6.00	7.62	61.35	4.55	0.98	4.66	76.00
Ash (% by weight)							
As Received	1.17	2.00	13.99	2.64	7.34	10.46	1.49
Dry Basis	1.25	2.17	36.19	2.77	7.41	10.97	6.21
Heating Value (BTU/lb)							
As Received	7,514	7,564	2,024	8,762	14,792	6,333	1,835
Dry Basis	7,994	8,188	8,762	9,180	14,938	6,642	7,644
Sample Composition As Received (% by weight)							
Ash	1.17	2.00	13.99	2.64	7.34	10.46	1.49
Chlorine	0.05	0.05	0.13	0.13	6.42	0.11	0.43
Sulfur	0.05	0.03	0.03	0.17	0.27	0.04	0.28
Nitrogen	0.24	0.20	0.45	4.44	0.15	0.24	0.54
Carbon	41.40	42.20	8.19	43.50	62.36	36.55	10.30
Hydrogen	5.73	5.75	1.15	5.78	9.48	5.59	1.51
Oxygen	45.41	42.20	14.84	38.92	13.00	42.46	9.45
Sample Composition Dry Basis (% by weight)							
Ash	1.25	2.17	36.19	2.77	7.41	10.97	6.21
Chlorine	0.05	0.05	0.34	0.14	6.48	0.12	1.80
Sulfur	0.05	0.03	0.07	0.18	0.27	0.04	1.15
Nitrogen	0.26	0.22	1.16	4.65	0.15	0.25	2.24
Carbon	44.04	45.68	21.20	45.57	62.98	38.34	42.92
Hydrogen	6.09	6.22	2.98	6.06	9.57	5.86	6.28
Oxygen	48.31	45.68	38.40	40.77	13.14	44.54	39.40

Table 3-8

COMPOSITE SAMPLES - CALCULATED ANALYSES

		DECEMBER '79	MARCH '80	JUNE '80	SEPTEMBER '80	WEIGHTED AVERAGE
Sample Composition, Dry Basis (% by weight)						
Carbon	(C)	31.42	33.63	35.40	35.26	33.96
Hydrogen	(H)	4.61	4.92	5.18	5.14	4.97
Nitrogen	(N)	0.60	0.79	0.67	0.90	0.74
Oxygen	(O)	31.97	32.74	34.12	36.35	33.80
Sulfur	(S)	0.16	0.29	0.16	0.24	0.21
Chlorine	(Cl)	0.66	0.84	0.83	0.63	0.74
Ash		30.66	26.95	23.22	21.68	25.65

Table 3-9

ASH FROM COMPOSITE SAMPLE - SPECTROGRAPHIC ANALYSIS

	%
Si	35.0
Al	8.5
Fe	4.0
Ca	7.5
Mg	0.75
Na	4.0
K	30.0
Ti	1.25
Zn	<0.05
Cu	0.015
Pb	0.05
Cr	0.4
Mn	0.02
Ni	0.005
Ba	0.03
Sr	0.02
Zr	<0.01
Sn	<0.003
B	<0.01
Co	<0.002
Ga	<0.002
Ag	<0.001
V	0.005

Ash Basis - reported as oxides of given elements

Table 3-10

COMPONENT SAMPLES - SPECTROGRAPHIC ANALYSES (%)

	Corrugated	Newsprint	Yard	Rubber Wood, etc.	Plastic	Mixed Paper
Silicon (Si)	15.0	*	*	25.0	40.0	40.0
Aluminum (Al)	10.0	17.5	12.5	3.0	10.0	20.0
Iron (Fe)	3.5	4.0	5.0	2.5	4.0	0.6
Calcium (Ca)	15.0	6.0	10.0	15.0	15.0	10.0
Magnesium (Mg)	6.0	10.0	2.0	1.5	5.0	1.0
Sodium (Na)	30.0	2.0	4.0	2.0	5.0	1.0
Potassium (K)	7.5	3.0	7.0	5.0	8.0	<0.75
Titanium (Ti)	0.35	2.5	0.85	5.0	2.5	7.0
Zinc (Zn)	<0.05	0.1	0.05	3.5	1.25	0.85
Copper (Cu)	0.07	0.12	0.008	1.5	0.015	0.025
Lead (Pb)	3.0	0.07	0.1	0.35	0.008	0.15
Chromium (Cr)	0.25	0.4	0.035	0.4	0.1	0.015
Manganese (Mn)	0.3	0.25	0.025	0.06	0.01	0.015
Nickel (Ni)	0.005	0.02	0.007	0.2	0.006	0.007
Barium (Ba)	0.08	0.12	0.2	0.8	0.08	0.5
Strontium (Sr)	0.04	0.02	0.05	0.04	0.1	0.03
Zirconium (Zr)	<0.005	0.007	0.02	<0.01	<0.01	0.01
Tin (Sn)	0.01	0.015	0.000	0.03	0.01	0.02
Boron (B)	0.75	0.05	0.03	0.05	<0.01	0.01
Antimony (Sb)				0.3		0.03
Cobalt (Co)		0.001	<0.002	0.01		0.002
Molybdenum (Mo)					0.007	<0.005
Gallium (Ga)	0.002	0.008	0.003		0.002	0.005
Gold (Au)						
Bismuth (Bi)				0.001		
Silver (Ag)			0.004	0.005	0.001	<0.001
Vanadium (V)	0.004	0.01	0.01	0.005	0.006	0.01

* Principal Constituent

Table 3-11

COMMERCIAL AND PRIVATE WASTE STREAM COMPOSITION

Item	Estimated Composition* (% by weight)
Newsprint	3.0
Corrugated	5.0
Other Paper	6.0
Rubber, Wood, Textiles, Etc.	15.0
Plastic	5.0
Yard Waste	15.0
Miscellaneous Organics	5.0
Ferrous	6.0
Glass	9.6
Aluminum	0.2
Other Nonferrous	0.2
Miscellaneous Inerts	30.0
	100%

* Based on visual observations during January 25-31, 1980.

REFUSE QUANTITY SURVEY

Survey Methodology

The first step in the quantity survey was installation of a vehicular weight scale at the Berkeley Landfill gatehouse. This permitted development of accurate weight for the three incoming waste streams.

For each of the three incoming streams, a different approach was used.

City: *Packer trucks were weighed beginning in January, 1980, for each day of the six-day collection week. This was interrupted several times for adjustments and repair of the scale.*

Commercial: *Haulers with billing accounts at the Berkeley Landfill were weighed beginning May, 1980. As no commercial accounts deliver on Saturdays, the study period was based on a five-day week.*

Private (cash-paying customers): *Beginning in May, 1980, six different categories of these vehicles were tallied each day. Over a two-day period, random vehicles in each category were selected for weighing. The average net weight for each category was then used to calculate the tonnage of this waste stream, based on available traffic counts.*

Survey Results

City: *From the data available, five one-week survey intervals were selected. These periods are shown in Table 3-12. City loads are delivered Monday through Saturday. The average delivery per week is 833 tons, or 119 tons per day on a seven-day basis.*

Table 3-12

QUANTITY SURVEY: CITY-COLLECTED REFUSE

Interval	Weight Delivered (lbs)	Weight Delivered (tons)	Delivery Rate (tons/day)
March 03-08	1,752,340	876	146
March 10-15	1,648,980	824	138
March 24-29	1,654,000	827	138
April 21-26	1,602,160	803	134
June 02-06	1,531,040	838*	140

** Corrected to include Saturday, June 7th*

Commercial: Three survey intervals are shown in Table 3-13. The average delivery per day is 123 tons, with a range (over the survey periods) of 100 to 150 tons per day. Commercial loads are delivered Monday through Friday only; one week's delivery is approximately 615 tons, or 88 tons per day on a seven-day basis.

Table 3-13

QUANTITY SURVEY: COMMERCIALLY-HAULED REFUSE

Interval	Days	Weight Delivered (lbs)	Weight Delivered (tons)	Delivery Rate (tons/day)
May 15-16	2	406,180	203	102
May 22,23,27-30	6	1,138,820	569	112
June 9,13,14,16-20	8	2,393,780	1,197	150

Private: On June 20 and 23, a survey was conducted at the Berkely Landfill to determine average vehicle payload according to the type of vehicle. Table 3-14 shows results of this survey. Using traffic count data, a weighted average payload of 1,075 lbs. for private deliveries was found.

Table 3-14

QUANTITY SURVEY: PRIVATELY-HAULED REFUSE

Vehicle	Average Net Weight (lbs)
Auto	274
Auto w/Trailer	845
Pickup	932
Pickup w/Trailer	2,390
Van	670
Flatbed/Stakeside Truck	3,107

Month-by-month totals of private deliveries to the Berkeley Landfill were obtained from the Berkeley Landfill operator (Table 3-16). Data for July and August, 1979 were not available; these were estimated based on other studies (Reference 3-4) and operators' experience. The average weekly delivery is 1,296 tons; the annual delivery is 70,800 tons.

Table 3-15 summarizes weekly deliveries from City, commercial and private vehicles and shows an overall annual delivery rate of 146,600 tons per year. This is well in excess of the 64,400 tons per year estimated in the 1978 Phase Two study (Reference 5). The difference can be attributed to larger than anticipated tonnage delivered to the site by private sources. The origin of this waste stream (i.e., Berkeley or other communities) was not determined in this study. The value of continuous, accurate use of the scale at the Berkeley Landfill cannot be overemphasized. Accurate weight, composition and origin data on the privately-hauled segment of the waste stream will be needed by the final designer of any waste-processing system for the City of Berkeley.

Table 3-15

BERKELEY LANDFILL DELIVERIES: A SUMMARY

Delivery Stream	Tons Delivered Per Week	Tons Delivered Per Year	Percentage of Total
City	833	43,300	30%
Commercial	625	32,500	22%
Private	1,296	70,800	48%
TOTAL	2,819	146,600	100%

Traffic Count

Traffic counts for early June have been combined and averaged to give a typical weekday traffic count and typical weekend traffic count for all deliveries to Berkeley Landfill. This is shown in Table 3-17.

Seasonal Variation

Due to the lack of continuous, long-term monthly data, only general conclusions may be drawn at this time in regard to important seasonal variations. The development of such a data base is essential for the determination of seasonal maximum and minimum delivery periods. Based on the available data, general conclusions are described below.

City: Scales data from March and June 1980 show approximately 5% greater density and tonnage delivered throughout the wet month, March, vs. the dry month, June. Moisture would account for density and tonnage variations. A strong seasonal variation was not found for tonnage delivered on a dry basis.

Table 3-16

PRIVATE DELIVERIES TO BERKELEY LANDFILL

Month	No. of Deliveries	Tons Delivered
July 1979	13,280	7,100*
August	14,060	7,600*
September	10,365	5,570
October	11,861	6,375
November	9,333	5,016
December	9,141	4,913
January 1980	8,715	4,684
February	8,735	4,695
March	11,345	6,098
April	11,121	5,978
May	12,406	6,668
June	11,258	6,051

* Estimated

Commercial and Private: Combined vehicle counts for commercial and private deliveries were 25% greater in May and June than in January. This is consistent with results from a similar study in Humboldt County (Reference 6). In that study it was also found that refuse deliveries during the months of May and June were quite similar to the annual average, with the lowest deliveries in December and January and highest in July and August. As July and August data become available, the same pattern will likely be confirmed for Berkeley.

Private deliveries, Table 3-15, show a variation ±25%, which is less than in the Humboldt County study. The expected increase in summer delivery may be partially offset by the reduced student population.

Future Quantities of Waste

A significant increase in waste generated within the City of Berkeley is unlikely. The City Planning Department estimates a maximum population of 120,000 in the year 2000; this is a 7.5% increase over the population of 111,500 reported in 1978. It is the opinion of City staff and others familiar with waste handling in the City that per capita waste generation is decreasing as citizens recycle, compost and otherwise reduce the amount of material they discard. Therefore, we may expect deliveries to Berkeley Landfill to remain essentially unchanged if the present collection system remains in effect.

Effects of Expanded Recycling Programs

A number of the existing recycling programs in the City are planning for expansion. These planned expansions, in addition to the implementation of Berkeley's Container Deposit Ordinance, will surely decrease the quantity of refuse delivered to a resource recovery facility. Estimates of future tonnage recovered through recycling are made by Mr. Terry Harrison, a special consultant on the project team with expertise in recycling programs in Berkeley. His methods and assumptions were:

- Quantities currently recovered by the various recycling groups were determined through personal interviews and the "Alameda County Recycling Centers Survey".
- Future recycling quantities were projected from an interview with Ecology Center staff, an unpublished study by the consultant for the Ecology Center in 1978 and "Home Separation of Recyclables in Berkeley".
- Berkeley's Container Deposit Ordinance will be implemented.
- Industrial recycling of corrugated boxes increases from the very low level found in 1978 to 50%.

His full report is presented in Appendix G.

Table 3-18 shows the current disposition of the following secondary material streams: ferrous metals; aluminum; glass; newspaper; and corrugated. The amounts shown for the waste stream currently disposed of at the Berkeley Landfill are based on the composition and quantities discussed previously.

Table 3-19 shows the projected future disposition of the identified secondary material streams under a scenario of expanded recycling. All amounts represent the maximum recoverable estimated by Mr. Harrison.

Table 3-20 shows the effect of expanded recycling on the composition of material expected at the proposed facility. Naturally, the percentage of the recycled material components decreases. (Both the newsprint and corrugated percentages decrease.) However, the other organic category percentages (rubber, wood, plastic, and yard waste) increase. Ferrous and aluminum percentages drop, as well as the glass percentage. Thus, the amount of material now coming to the landfill which might be directed to the proposed facility decreases from 146,600 tons per year to 137,500 tons per year. However, no decrease in BTU value per ton is assumed because the overall organic percentage remains approximately the same.

Table 3-17

BERKELEY LANDFILL TRAFFIC COUNT

	WEEKDAYS (Average, Week of June 2)		
	Private	Commercial	City
8:00 - 10:30 AM	83	12	12
10:30 - 12:30 PM	71	6	12
12:30 - 2:30 PM	82	5	12
2:30 - 4:30 PM	47	3	4

	WEEKEND			
	Private		Commercial	City (Saturday Only)
	Saturday	Sunday		
8:00 - 10:30 AM	156	110	0	4
10:30 - 12:30 PM	160	112	0	3
12:30 - 2:30 PM	115	80	0	0
2:30 - 4:30 PM	155	110	0	0

Table 3-18

CURRENT DISPOSITION OF SECONDARY MATERIALS*a
(Tons Per Year)

	Ferrous	Aluminum	Glass	Newspapers	Corrugated
Currently Recycled:					
Ecology Center	-	-	-	960	-
Recovery	4	1	16	2	4
Berkeley Youth Altern.	5	3	73	4	68
Community Cons. Ctr.	90	18	1020	600	72
Berkeley Landfill	1,100	60	-	-	-
Industrial Recycling	550	5	-	-	140
Commercial Recycling	-	-	110	-	1,700
Currently Landfilled:					
Berkeley Landfill					
City*b	1,535	330	4,270	4,150	2,905
Commercial/Private*c	5,200	150	10,100	3,150	5,250
Other Landfill					
Commercial (Berkeley source)	-	-	-	-	280
Industrial (Berkeley source)	24	-	80	-	849
TOTAL	8,508	567	15,589	8,866	11,268

*a Based on T. Harrison's report.
*b Based on composition survey of Berkeley city trucks.
*c Based on estimated composition of commercial/private minus amount currently recycled at Berkeley Landfill.

Table 3-19

PROJECTED FUTURE DISPOSITION OF SECONDARY MATERIALS*a
(Tons Per Year)

	Ferrous	Aluminum	Glass	Newspapers	Corrugated
Recycled:					
Container Ordinance	54	20	238	-	-
Ecology Center	320	30	1,400	1,900	-
Recovery	1	1	3	2	1
Berkeley Youth Altern.	5	3	73	4	68
Community Cons. Ctr.	180	20	1,500	2,300	660
Berkeley Landfill*b	1,600	80	-	-	-
Industrial Recycling	550	5	-	-	800
Commercial Recycling	-	-	150	-	2,000
Total	2,710	159	3,364	4,206	3,529
Disposed at Other Landfills:					
Commercial	-	-	-	-	360
Industrial	30	-	115	-	1,100
Total	30	-	115	-	1,460
Transfer Station/Resource Recovery Facility*c	5,768	408	12,110	4,660	6,279

*a Based on T. Harrison's report.

*b It is conservatively assumed that secondary materials currently recovered at the Berkeley Landfill will be recovered at the on-site recycling center and not available to the resource recovery facility.

*c These tonnages derived by subtracting projected future recycled and landfilled quantities from totals reported in Table 3-18.

Table 3-20

RECYCLING EFFECT ON COMPOSITION

Category	% Now at Landfill *a	Avail. Qty. (tons) *b	Recycled (tons) *c	Anticipated Qty. at Facility (tons)	% Anticipated at Facility
Newsprint	5.0	8,866*d	4,206*d	4,660	3.4
Corrugated	5.6	11,268*d	4,989*d	6,279	4.6
Other paper	13.4	19,640	-	19,640	14.3
Rubber, wood, etc.	11.8	17,300	-	17,300	12.6
Plastic	5.6	8,210	-	8,210	6.0
Yard waste	12.8	18,760	-	18,760	13.6
Misc. organics	7.4	10,850	-	10,850	7.9
Ferrous	5.4	8,508*d	2,740*d	5,768	4.2
Glass	9.7	15,589*d	3,479*d	12,110*d	8.8
Aluminum	0.4	567*d	159*d	408	0.3
Other nonferrous	0.2	290	-	290	0.2
Misc. inerts	22.7	33,280	-	33,280	24.2
TOTAL*b	100%		15,573	137,500	100%

*a Weighted average of compositions presented in previous tables
*b Includes both currently recycled and landfilled
*c Projected quantities recovered through expanded recycling programs
*d Taken from Table 3-18

CHAPTER 4

FRONT-END PROCESS TECHNOLOGY

INTRODUCTION

One objective of the City's Solid Waste Management Center Phase Two Study was to identify appropriately-scaled systems to recover materials and energy from Berkeley's waste stream. Recommendations resulting from the study effort concluded that the City should pursue development of a modular combustion system producing steam. In addition, it was recommended that the City consider some front-end processing of the refuse to improve combustion, reduce ash production and recover secondary materials. This chapter examines the possible front-end processing technologies available to Berkeley to achieve these goals.

Only those technologies found to be compatible with the modular combustion system and Berkeley's waste quantities are analyzed and compared with a base case of mass burning. Mass burning as defined here refers to the use of raw, unprocessed refuse as a fuel for modular combustion units producing steam. In this approach, inorganics and noncombustible materials remain in the waste stream. Mass burning is employed in Salem, Virginia; North Little Rock, Arkansas; and most other existing modular combustion installations of 100 tons per day (TPD) or more.

Some smaller installations burning 10-15 TPD utilize source separation to remove cans and glass from the waste stream. This serves mainly to reduce slag formation which creates maintenance problems with refractory in these batch-fed systems. Certainly Berkeley's proposed source separation system could aid in reducing the amount of inorganic and noncombustible material from the fuel stream, however, based on available data on estimated quantities recoverable through a City-wide source separation program in Berkeley, additional processing is necessary to significantly aid the combustion characteristics and reduce ash in the system.

Cost and benefits of the selected front-end process technology are examined and compared with the mass burning alternative to determine the most suitable approach for Berkeley. The analysis assumes magnetic recovery of ferrous material is included in all processes investigated since this technology is well developed. In addition, since hand-sorting is the most widely applied separation technique, it is assumed employed as appropriate, with both the mass burning and the process technology alternative.

PROCESS SELECTION

In the 1960's, processing of municipal solid waste (MSW) to produce a suitable fuel for combustion consisted of size reduction and magnetic ferrous recovery systems. Today, air classification and trommeling are used to remove inorganic and noncombustible material. In addition, ball milling, in conjunction with chemical additives and densification such as pelletizing, has been employed to improve storage and shipping characteristics of the prepared fuel. Sophisticated equipment to recover aluminum and glass has also been employed.

These approaches have achieved varying degrees of success and each is applicable on a very specific basis. Berkeley's waste quantities and the use of a modular combustion system narrows down front-end technologies that are appropriate.

Front-end process technologies examined include:

- *Size reduction (Fig 4-1)*
- *Size reduction followed by air classification (Fig 4-2)*
- *Trommeling (Fig 4-3)*

Disc separators represent another technology that is employed to a limited degree in processing solid waste. Basically, it is a size-selective screening device utilizing rotating, multiple, parallel discs to separate oversize from undersize fractions similar to a trommel. These units are still in the developmental stage in regard to MSW processing and, further, they perform the same function as trommeling. It is, therefore, recommended that disc separation not be included in front-end process selection for Berkeley. A discussion of applicable front-end technologies and their suitability to Berkeley's situation follows.

SIZE REDUCTION

General

Size reduction, as defined here, is the conversion of raw MSW to a smaller particle size. The objective is to obtain a final product of greater uniformity and of smaller particle size than the original input waste. Size reduction can be beneficial to resource recovery operations since most separation devices require feeds of reduced uniform particle size.

Description

Size reduction devices for MSW generally fall into one of the following categories:

- *Hammermills - often called shredders, are available in both vertical and horizontal orientation. Hammers are rotated at high speed; impact and shearing action between hammers and stationary breaker plates and grates cause feed to break into particle sizes small enough to pass through the grates located at the bottom of the mill.*

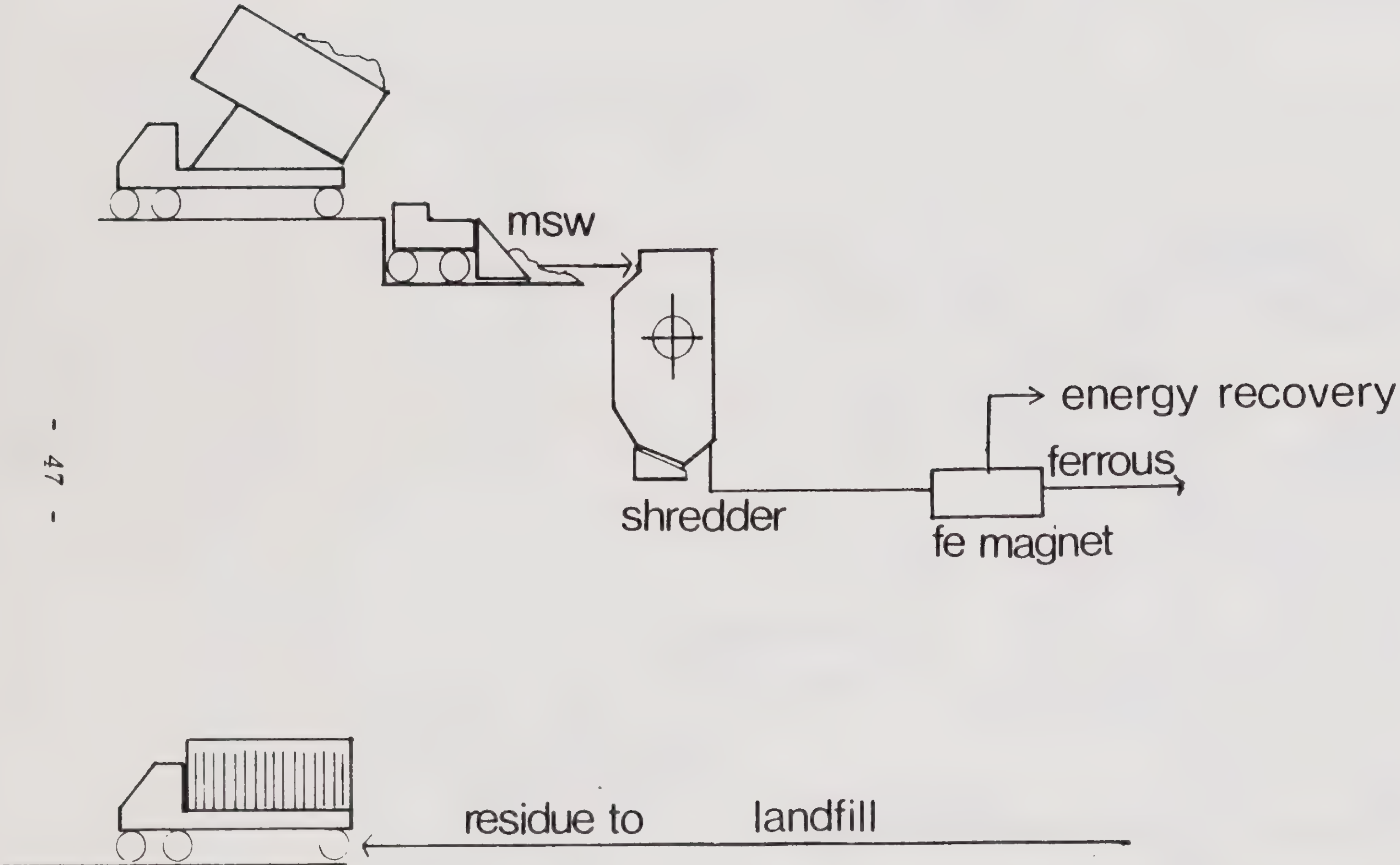
  Variations of hammermills are used to satisfy specific requirements. One such variation called a flail mill does not use grates. As a result, the product is larger and less predictable than conventional hammermilling.

  Hammermills are considered generally effective with numerous installations showing years of operating experience.

- *Shear shredders - a relatively new application to MSW, shear shredders size MSW with cutters rotating at much lower speeds than do hammermills. Particle size is controlled by adjusting cutter configuration.*

  Shear shredders of the size required for application in Berkeley are currently in the developmental stage. However, smaller capacity equipment has been successfully demonstrated.

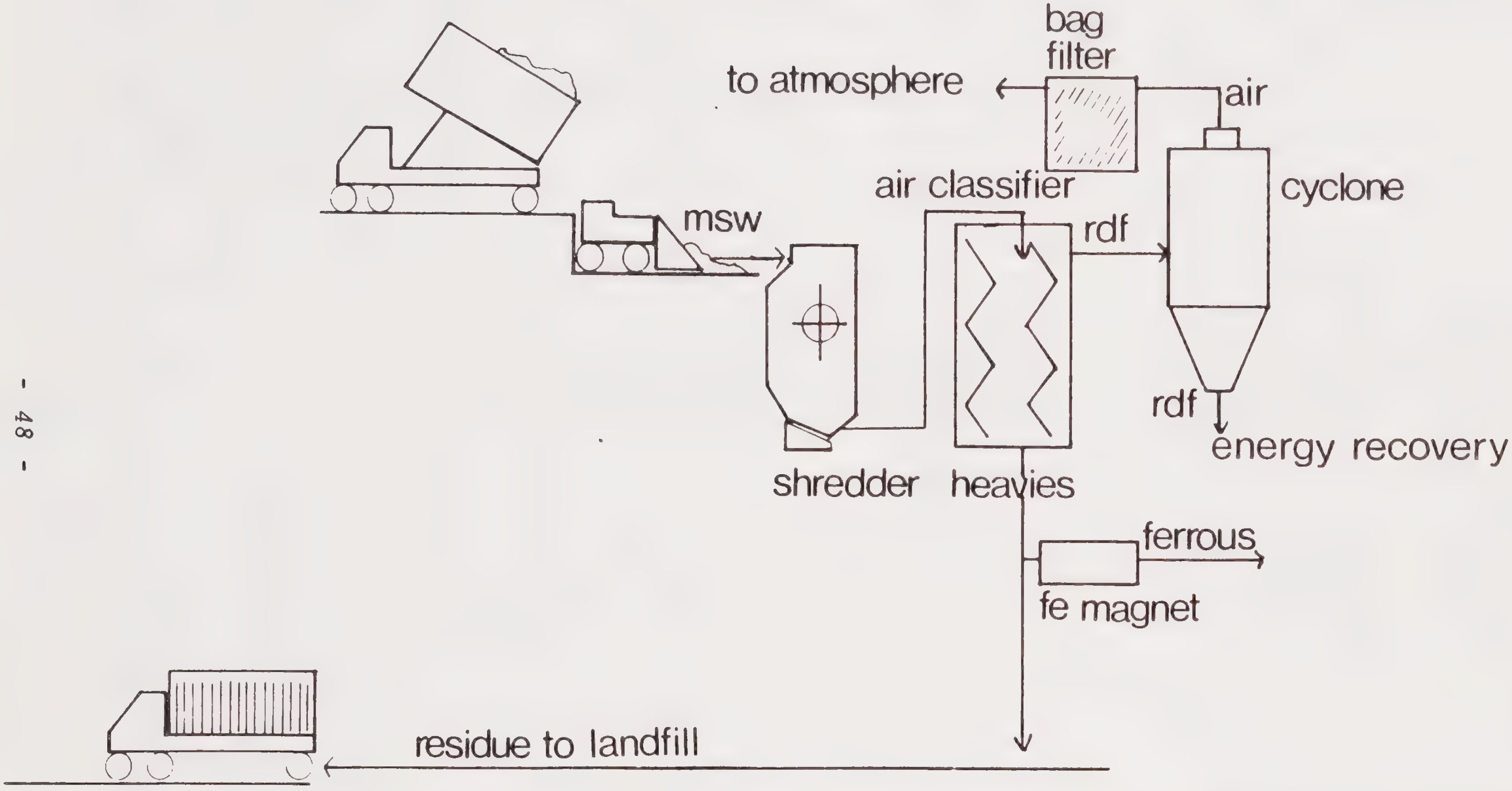
The recovery of ferrous cans is achieved with a magnetic recovery system after shredding. Aluminum recovery is not practical when shredding is the only processing technology.



BROWN, VENCE & ASSOCIATES
Energy and Environmental Engineers

City of Berkeley
Size Reduction

FIGURE 4-1



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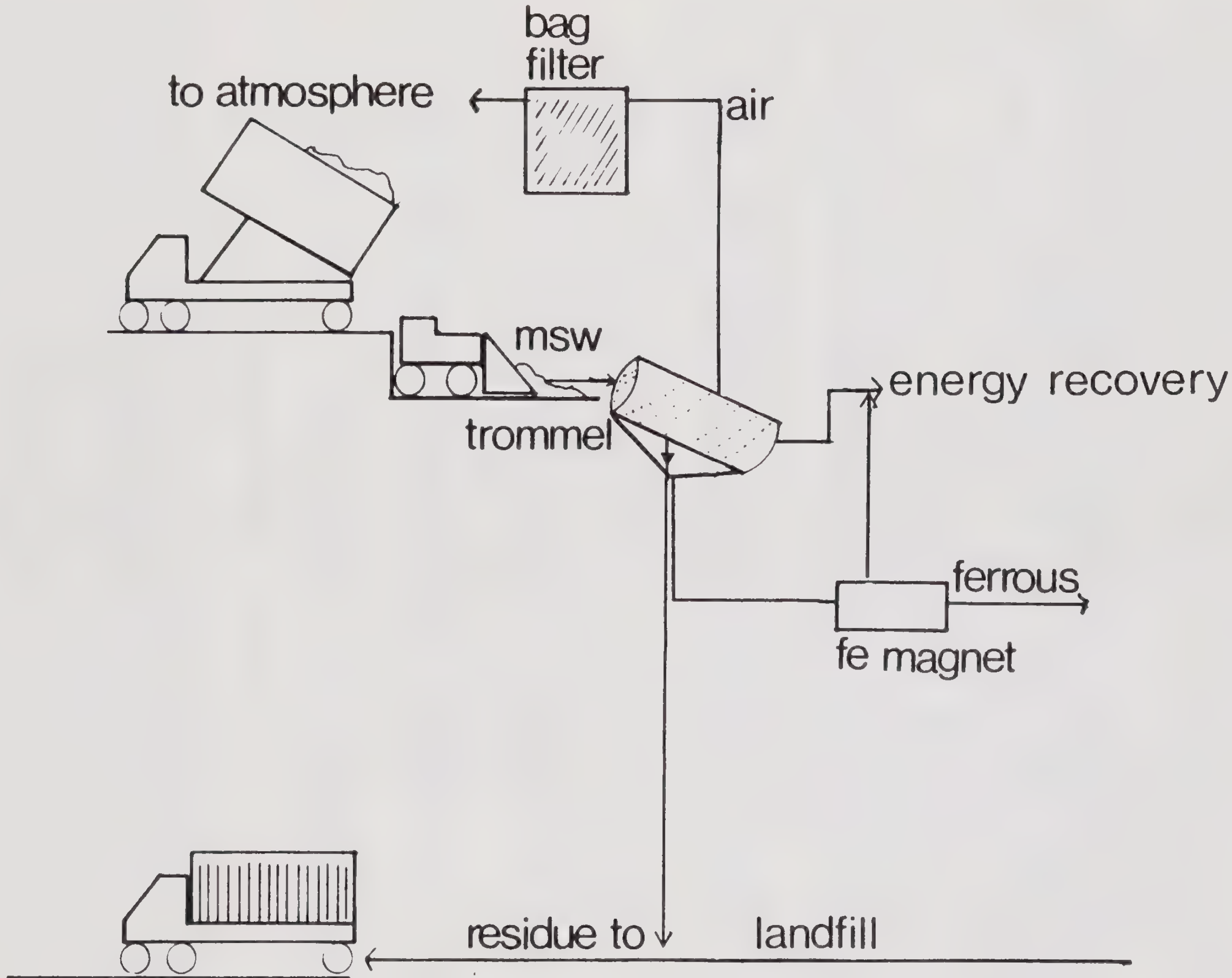
Energy and Environmental Engineers

City of Berkeley
Size Reduction
Followed By
Air Classification

FIGURE

4-2



BROWN, VENCE & ASSOCIATES
Energy and Environmental Engineers

City of Berkeley
Trommeling

FIGURE
4-3

A typical size reduction system consists of conveyors for feeding and retrieval of product, size reduction equipment and provisions to reduce explosion hazards.

Capital, operating and maintenance costs of size reduction equipment are relatively high. Hammers must be inspected and maintained frequently. Shutdown problems are common and explosions are a significant hazard that must be dealt with in both design and operation.

Size reduction equipment is employed in virtually every resource recovery facility around the country and is also utilized in many landfill operations that shred before disposal.

Applicability of Size Reduction to Berkeley Solid Waste Management Center (SWMC)

Size reduction alone is of little benefit to Berkeley SWMC and is not recommended for the following reasons:

- *A high incidence of noise and dust generation exists.*
- *Modular combustion units are designed to accept MSW in its raw, bulky state. There exists no reliable information on the effect of shredding on the combustion efficiency of modular units.*
- *With the exception of some handsorting prior to processing and removal of ferrous cans through magnetic separation, inorganics and noncombustible material are not removed by size reduction.*
- *Downtime potential increases and a prohibitively high cost for redundancy exists.*
- *The relatively small quantity of waste available to the SWMC would result in a high cost per ton for this processing option.*
- *The SWMC would be exposed to safety hazards due to potential explosions in shredders.*

SIZE REDUCTION FOLLOWED BY AIR CLASSIFICATION

General

Air classification is used in resource recovery to remove inert, noncombustible material from the waste stream. Beneficial effects on the resulting fuel include improved heat content, low ash content, and high potential for resource recovery. All air classifiers rely on differing particle sizes, densities and resulting bouyant forces. Raw MSW must be size-reduced prior to air classification in order to achieve the desired particle sizes. Size-reduced MSW is separated by density using air flowing in a variety of orientations. Existing processes employ either forced air, induced draft or some combination thereof.

Description

After size reduction, MSW is introduced into the moving air stream through a device that provides an air lock. The air lock is required to maintain proper air flow in the system. Light fractions (such as paper and plastic) are carried downstream and are separated from the air stream using a disengaging device, usually a cyclone. At this point, the light

fraction is a refuse derived fuel (RDF) and may be stored or fed directly to the combustion process. Heavier fractions composed primarily of inert, noncombustible material drop through the moving air stream and are removed either at the air entry point or through an air lock.

Magnetic ferrous recovery is achieved both after shredding, as in the size-reduction alternative, and from the heavy fraction out of the air classifier. Aluminum may also be recovered from the heavy fraction; however, specialized equipment and further processing is required.

In addition to size-reduction equipment, the air classification system consists of the classifiers, pneumatic ductwork, a disengaging device, conveyors, fans and a baghouse for dust control. The systems require operator attention due to seasonal variation in MSW composition and moisture content. The devices for system inlet feeding and product removal often jam, requiring operator attention and maintenance. As a result of these factors, owning and operating costs are relatively high for Berkeley's waste quantities.

The use of air classification following shredding is practiced in many resource recovery installations including Ames, Iowa; Recovery I, New Orleans, Louisiana; and Baltimore County, Maryland (Teledyne).

Applicability of Size Reduction Followed By Air Classification to Berkeley's SWMC

Air classification is not recommended as a process technology for Berkeley's SWMC for the following reasons:

- *Modular combustion units are designed to accept MSW in its raw, bulky state. There exists no reliable information on the beneficial effects of shredded air-classified MSW on the combustion efficiency of modular units.*
- *A high incidence of noise and dust generation exists.*
- *Aluminum recovery requires expensive and sophisticated recovery equipment which can't be justified with Berkeley's waste quantities.*
- *The SWMC would be exposed to safety hazards due to potential explosions in the shredder.*
- *Downtime potential increases and a prohibitively high cost for redundancy exists.*
- *The relatively small quantity of waste available to the SWMC would result in a high cost per ton for this processing option.*

TROMMELING

General

Trommeling of MSW is a relatively new application step in solid waste processing. It is usually the first step in the processing line regardless of the degree of processing desired and results primarily in the removal of inorganic, noncombustible material from the waste stream.

Trommeling is the mechanical separation of material by a rotating cylindrical screen. The method, first developed for ore processing, has since proven its utility in MSW resource recovery operations.

Description

MSW is charged to the cylinder via a steel pan conveyor. The larger, mostly combustible, solids move through the unit as the oversize fraction. It is this oversize fraction that will be used for charging the modular combustion units. Material that falls through the screen openings (there are openings the length of the cylinder) is called the undersize fractions. Numerous lifters are provided in the barrel interior to facilitate movement of the material through the trommel. The lifters aid in the tearing and tumbling action, causing bagged and bundled refuse to break open, liberating the contents and creating opportunities for separation.

Since some of the combustibles are removed in the undersized stream, there is an overall reduction in steam generation potential as compared to mass firing the MSW, however, removing the inerts, of which the undersize is predominantly composed, from the combustion charge results in a more uniform feed of higher heating value with much lower ash than mass firing would provide. This would tend to reduce undesirable load swings in steam generation.

Screening rates for aluminum and ferrous can stock are high so these resources are recovered predominately in the undersize fraction. Separation from the undersize is obtained magnetically for ferrous cans and by handsorting for the aluminum cans.

A trommeling operation consists of a conveyor system, trommel and dust collection system. No unusual maintenance or safety problems have been identified with trommeling in existing operations. Although the capital cost is relatively high (but lower than shredding), the cost is offset somewhat by the savings in modular combustion costs. This savings is a direct result of requiring fewer combustion units, since a good portion of the waste has been separated out before combustion. In addition, savings accrue by reducing maintenance on the combustion units, since the inerts are removed prior to combustion. These inerts are abrasive, tend to slag and create excessive maintenance requirements in both refractory and metal parts.

Trommeling as a processing step prior to MSW combustion has been demonstrated successfully in England since 1957 and in the U.S. since 1972. The most notable examples in this country are test results at:

- *NCRR in Washington, D.C.*
- *Reynolds Aluminum in Richmond, Virginia*
- *Recovery I in New Orleans, Louisiana*

The Recovery I application has been run continuously and successfully since 1977 as an operational and testing facility. A full-scale trommel operation is now in shakedown for BFI at their Houston, Texas location. The EPA has recently completed testing of a trommel as a front-end process technology at the North Little Rock modular incinerator facility. Similar testing has also been done in the Salem, Virginia facility.

Applicability of Trommeling to Berkeley's SWMC

Trommeling is recommended as a process technology for Berkeley's SWMC for the following reasons:

- *The end product from trommeling is compatible with modular combustion units with respect to particle size, method of feeding and operational experience.*
- *Trommeling provides a good quality fuel product for combustion units.*
- *There is low noise generation, and dust generation is easily mitigated.*
- *No extraordinary maintenance costs have been identified.*
- *It offers the lowest owning and operating costs of alternatives identified. In addition, these costs are somewhat offset by savings in capital and operating costs of combustion units.*
- *Trommeling, when compared to air classification, achieves greater reduction in ash production and at a lower cost.*
- *No extraordinary safety hazards are associated with trommeling. Explosion potential is less than that of shredding.*
- *Trommeling affords an excellent opportunity for resource recovery.*

EVALUATION OF TROMMELING VS. MASS BURNING

In order to evaluate the effectiveness, both technical and economical, of a selected processing technology — in this case trommeling — it is necessary to establish a do-nothing baseline. For the purpose of this analysis, mass burning is the do-nothing alternative. Consequently, this section will evaluate trommeling vs. mass burning. A recommendation that will best fit Berkeley's needs is developed.

Some effects of mass burning and trommeling are summarized below:

- *Mass burning yields a lower unit heat value of fuel product, larger residue of ash, a higher modular combustion system cost and more energy recovery.*
- *Trommeling yields a smaller volume of fuel with higher heat content, less ash residue, a lower modular combustion system cost, an additional cost for the front-end processing system, a higher potential for materials recovery and lower total energy recovery.*

Evaluation Criteria

The criteria used to analyze the effectiveness of trommeling include:

- *Net energy available - This is the effective heat input in BTU's available to the combustion process.*

- *Net energy output* - This relates to thermal efficiency and net energy available. Net energy output is expressed in revenue ($) per ton of incoming MSW based on 100% electrical generation.

- *Process residue disposal* - Residue, as defined here, is the unburned discards in the undersize from the trommeling operation. The undersize is a nonhazardous waste which can be disposed of at a Class II disposal site. The haul and disposal cost of this residue impacts on the overall project economics and is expressed in cost per ton of incoming MSW.

- *Wet combusted ash and fly ash disposal* - After combustion, partially combusted organic material and the incombustibles present in the feedstock remain as ash, which is then cooled by a water quench. For this analysis, it is assumed that a burn-out rate of 90% will be achieved; i.e., 90% of combustible material in the feedstock will be combusted to inert ash and 10% will remain in the ash as unburned combustibles.

  In California, ash from the combustion of MSW is classified as a hazardous waste requiring disposal in a Class I disposal site, "unless the producer can show that it would not violate water quality regulations," in which case it may be approved for a Class II-1 site or another site that is permitted to accept it. A Class II-1 site has less stringent requirements and a lower disposal fee than a Class I site.

  The cost of ash disposal impacts significantly on project economics since disposal cost at a Class I site is approximately eleven to thirteen times that for nonhazardous wastes at a Class II site. Again, disposal costs are expressed as cost per incoming ton of MSW. Transportation costs are included.

- *Secondary materials recovery* - The compatibility of secondary materials recovery rather than revenue received is the primary consideration here.

- *Net cost* - The net cost of the two alternatives is developed based upon residue and ash disposal costs and the value of energy produced. This cost includes the additional capital and operating costs associated with the trommeling operation and three extra combustion units needed if mass burning is employed. Net cost is expressed in cost per incoming ton of MSW.

Results & Recommendations

Table 4-1 summarizes the evaluation of mass burning vs. trommeling. As seen from this table, trommeling provides a savings of $29.20 over mass burning when utilizing a Class I disposal site and $13.10 when using a Class II-1 disposal site. Trommeling increases resource recovery cost if ash can be disposed of with general refuse at a Class II landfill. The predominant factor affecting these differences is the combustion ash disposal cost. Reducing the amount of this hazardous waste, then, is the most important benefit of trommeling. Of course, the ability to recover secondary materials will provide a favorable impact on both the project economics and the contribution to further the development of resource recovery for the City.

If ash requires special handling, it is recommended that processing using trommeling be incorporated in the energy recovery portion of Berkeley's SWMC.

Table 4-1

EVALUATION OF MASS BURNING vs. TROMMELING

	MASS BURNING Wet Ash Disposal @ Class I	MASS BURNING Wet Ash Disposal @ Class II-1	MASS BURNING Wet Ash Disposal @ Class II-2	TROMMELING Wet Ash Disposal @ Class I	TROMMELING Wet Ash Disposal @ Class II-1	TROMMELING Wet Ash Disposal @ Class II-2
Net Energy Available (BTU x 10^6/Ton Input)	9.566	9.566	9.566	6.031	6.031	6.031
Net Energy Output-Value ($/Ton MSW Input)	$23	$23	$23	$16	$16	$16
Trommel Residue Disposal Cost ($/Ton MSW Input)	-	-	-	($3.7)	($3.7)	($3.7)
Wet Combustion Ash Disposal Cost ($/Ton MSW Input)	($49)	$28	($8)	($11.8)	($4.9)	($1.5)
Owning & Operating Cost of Additional Equipment ($/Ton MSW Input)	($4)	($4)	($4)	($1.3)	($1.3)	($1.3)
Potential Secondary Materials Recovery	-	-	-	Al & Ferrous Cans	Al & Ferrous Cans	Al & Ferrous Cans
(Cost) Net Saving ($/Ton MSW Input)	($30)	($7)	$11	($0.8)	$6.1	$9.5

Table 4-1 is based on the following assumptions:

1. *Disposal costs are based on the following:*

   - *Trommel residue at a Class II site - \$7.00/ton; 800 lbs/yd³*

   - *Ash*

	Trommel @ 950 lb/yd³	Mass Burning @ 1300 lb/yd³
Class I site	\$106/ton*a	\$77/ton*a
Class II-1 site	\$40/ton*b	\$40/ton*b
Class II-2 site	\$7/ton*b	\$7/ton*b

   - *Transportation costs*

	Trommel Residue	Ash
Class I site	-	\$7/ton
Class II site	\$3.90/ton	\$7/ton

2. *Energy value is based on:*

   - *55% boiler efficiency for mass burning*
   - *60% boiler efficiency for trommeled feedstock*
   - *1070 BTU's per pound of steam*
   - *13 lbs. steam per KWHR*
   - *\$.062 average revenue per KWHR*

3. *Trommel residue production at the rate of 34% of incoming MSW on as-received basis.*

4. *Trommel fuel fraction at the rate of 53% of incoming MSW on as-received basis.*

5. *Ash production at the rate of:*

   - *7.1% of incoming MSW for trommeled feedstock on as received MSW basis*
   - *40% of incoming MSW for mass burning on as-received MSW basis*

6. *Estimated capital cost of the trommeling operation is \$989,000.*

Amortization over 20 years @ 9%:	108,300
The O&M cost is estimated at (including labor):	75,000
Therefore, yearly owning and operating cost is:	\$183,300

---

*a @ \$50/yd³ (West Contra Costa Landfill)
*b West Contra Costa Landfill

7. *Estimated capital cost of three additional combustion units for mass burning is $3,600,000:*

Amortization over 20 years @ 9%:	394,000
The O&M cost is estimated at:	150,000
	544,000

8. *Yearly input MSW estimated at 137,500 tons per year.*

9. *Fuel Product Heat Value (as received @ 30% moisture)*

   - *Mass Burning - 4780 BTU per pound of fuel product*

   - *Trommeling - 5690 BTU per pound of fuel product*

10. *Ash moisture content after water quench - 32%.*

CHAPTER 5

POLLUTION CONTROL REQUIREMENTS

The purpose of this chapter is to assess the need for project environmental control requirements with respect to potential air, water, residue and noise pollution. Where requirements are identified, mitigating measures are recommended.

AIR QUALITY

Introduction

The following section on air pollution control requirements is based on a report prepared by R.G. Lunche, a consultant retained by BVA. On April 11, 1980, BVA and Mr. Lunche met with the Bay Area Air Quality Management District (BAAQMD). The BAAQMD had been given a copy of the prepared report in advance of the meeting. The report was then discussed at the meeting, especially the emissions projections, applicable regulatory standards, and implications of the emissions projections with respect to action by the BAAQMD. The following paragraphs are based on the report and are supplemented from the meeting where appropriate. The full report is presented in Appendix H.

Combustion units of the design being considered for this project have been installed in the 50 ton-per-day (TPD) size in Auburn, Maine (facility currently under construction) and in the 25 TPD size and operated in Siloam, North Little Rock, Osceola, Arkansas; and Salem, Virginia. Emission source tests of the North Little Rock facility have been conducted and reported by Systems Technology Corporation (SYSTECH) (Reference 7). These tests were part of a study sponsored by the U.S. Environmental Protection Agency (EPA) and the California State Solid Waste Management Board. Results of these tests are used to project emissions from the proposed facility. These are then evaluated against applicable regulatory standards and permitting requirements of the BAAQMD and EPA. Appropriate air pollution control techniques are also identified.

Standards

The proposed project will be located in the jurisdiction of the BAAQMD. The facility must comply with emission standards, New Source Review standards, permitting standards, new plant performance and emission requirements, and hazardous pollutant standards of the BAAQMD. In addition, the facility is subject to Prevention of Significant Deterioration (PSD) review by the EPA.

The most stringent and, therefore, controlling standards are the requirements of the New Source Review Rule. The rule essentially prohibits the issuance of a permit to facilities that emit a total in excess of 150 pounds per day (lbs/day) of any contaminant covered by a state or national ambient air quality standard (NAAQS), unless it is shown that the facility is constructed using the best available control technology (BACT). The sole exception is carbon monoxide, the limit of which is defined by the BAAQMD air pollution control officer.

Furthermore, if the facility emits a total in excess of 250 lbs/day of such contaminants (except NO_x - 550 lbs/day and CO - undefined after control), the facility is subject to emission offsets. Special offset exemptions are currently established for resource recovery projects under Assembly Bill 524 (Calvo). The legislation is discussed further in Chapter 8.

Emissions

Emissions from the proposed project combustion units are developed by using average emission factors from the North Little Rock tests. Table 5-1 shows these emission factors. One 50 TPD unit generates sufficient particulates to require controls. As can also be seen in the Table, nitrogen oxides (NO_x) will require BACT.

Control Requirements

Table 5-2 shows a comparison between plant emissions with particulate control and regulatory standards for both three 50 TPD units and four 50 TPD units. For a three 50 TPD facility, BACT is required for NO_x; special exemptions or offsets as a resource recovery facility (AB 524) are also required. For a four 50 TPD facility, BACT is required for NO_x and perhaps for SO_2. The resource recovery exemptions or offsets are also required for NO_x.

For particulates, electrostatic precipitators, baghouses or dry scrubbers are possible control technologies. Lead and possibly sulfates (SO_4) will also be controlled by the particulate control device. A brief discussion of the three best particulate control technologies is given below:

- *Electrostatic Precipitators: Precipitators (ESP) employ high voltages to impart an electrostatic charge to dust particles in the gas stream. The particles then move to and adhere on collecting electrodes having an opposite charge.*

  This technology requires high capital and operating costs and large space requirements; the shaking of plates is necessary for particle collection. It may not be considered as BACT in California.

- *Baghouses: Fabric filters, or baghouses, remove the particulate matter by means of filtration principles. In this system, a cooled gas stream passes through woven or felted cloth at low velocity. The particulate matter filtered out collects on the fabric which may be made of wool glass, or synthetics and may be in the shape of tubes (bags), envelopes or plate-formed pockets.*

  This technology requires high capital and operating costs, and large space requirements and is prone to fire hazards and bursting problems. It is now being considered for designation as BACT in California.

- *Dry Scrubbers: A dry scrubber removes particulate matter from gas streams in a dry form using a moving bed of filter media (pea-sized gravel) and an electrically-charged grid within the bed to augment impaction. Ash is collected in dry form and removed by a pneumatic media recirculation and cleanup system.*

  This technology requires moderate capital and operating costs and minimum space is required. It is considered a relatively new technology. The units have been utilized on wood-burning boilers, pulverized coal burners, at a steel mill for coke calcining and a lime kiln. The first application on a solid waste project will occur in Pittsfield, Massachusetts (240 TPD) where a dry scrubber (90,000 cfm) will be applied to the combustion process of modular combustion units. This facility will be on-line in 1981-82.

The air pollution control device recommended for this project is the dry scrubber. Its capital costs and size are less than the ESP, while its operating costs are less than the baghouse. Dry scrubbers avoid the fire and explosion hazards of baghouses, while retaining high collection efficiencies.

BACT for nitrogen oxides (NO_x) and sulfur dioxide (SO_2) is uncertain. In place of an equipment standard, a performance standard may be imposed. As an example, Pacific Gas and Electric's BACT performance standard for their proposed Collinsville coal-fired power plant is 0.4 lb NO_x per million BTU of input fuel.

BACT for SO_2 from modular incinerators is undefined. If six (6) lbs (or more) is found to be controlled (as sulfate, SO_4, particulate) by the particulate control device, BACT may not be required.

In summary, particulate control is required while requirements for NO_x control must be negotiated with the BAAQMD. Negotiations should begin as soon as possible after the selection of a manufacturer's modular combustion unit.

Dump Stacks

In the event of a boiler failure requiring steam production to be halted, combustion gases are emitted through dump stacks. Although temporary emissions are permitted by air pollution regulations, it should be noted that complete burnout and shutdown of modular combustion units requires several hours. An excursion of this length may not be permitted. As a result, facility design (refer to Chapter 6) includes tying in the dump stacks to the dry scrubber system.

Cooling Tower

Conventional cooling towers generate a plume of water vapor. The water vapor is produced through the dissipation of heat from water used to condense boiler loop steam. For aesthetic reasons, the facility design includes an abatement cooling tower which minimizes the existence of a plume.

Table 5-1

ESTIMATED PLANT EMISSIONS

POLLUTANT	Emission Factor*a (lb/ton)	1-50 TPD UNIT Uncontrolled Emissions (lb/day)	Control Factor	3-50 TPD UNIT Emission (lb/day)	4-50 TPD UNIT Emissions (lb/day)
Particulate*b	3.03	151.5	.1*c	46	61
Hydrocarbons	.55	27.5	1.0	83	110
Carbon Monoxide	1.00	50.0	1.0	150	200
Sulfur Dioxide	.78	.39	1.0	117	156
Nitrogen Oxides	3.68	184.0	1.0	552	736
Lead	.14	7.0	.1*c	2.1	2.8

*a From North Little Rock study (Reference 7). Units are pounds of pollutants per ton of combusted product.
*b Does not include fugitive dust inside plant. This dust will be captured and controlled with collection hoods, ducking and a baghouse.
*c Based on a conservative estimate for control device.

Table 5-2

PLANT EMISSIONS vs. NEW SOURCE REVIEW STANDARDS

POLLUTANT	PLANT EMISSIONS (lb/day)		REQUIRES BACT*a		REQUIRES EXEMPTIONS/ OFFSETS*a	
	3-50 TPD Units	4-50 TPD Units	3-50 TPD Units	4-50 TPD Units	3-50 TPD Units	4-50 TPD Units
Particulate	46	61	NO	NO	NO	NO
Hydrocarbons	83	110	NO	NO	NO	NO
Carbon Monoxide	150	200	NO	NO	NO	NO
Sulfur Dioxide	117	156	NO	MAYBE*b	NO	NO
Nitrogen Oxides	552	736	YES	YES	YES	YES
Lead	2.1	2.8	NO	NO	NO	NO

*a BACT is required over 150 lb/day; offsets required over 250 lb/day, except NO_x - 550 lb/day; CO is an automobile-related pollutant with no limit defined.

*b If six (6) lbs (or more) is found to be controlled (as SO_4 particulate) by the particulate control device, BACT may not be required.

WATER

Introduction

The proposed facility will use water for start-up, boiler makeup, cooling tower operations and general facility requirements. Water will be obtained from the East Bay Municipal Utility District (EBMUD) supply mains. Wastewater will be discharged to the EBMUD sanitary sewer system. Some water will be reclaimed in the facility for ash quenching purposes and discharged with the ash in an appropriate landfill.

Water Requirements

Ninety-five percent (95%) of the boiler system requirement is recycled through a condenser. Five percent (5%) is lost through boiler blowdown and requires replenishing. The major use of water by the proposed facility is for cooling tower operations. Cooling water, used to condense boiler loop steam, will flow through mechanical draft cooling towers. Ninety-six percent (96%) of the water is recirculated because the cooling system is closed. Four percent (4%) is needed for makeup. Approximately 80% of this makeup is evaporated, and 20% is discharged as blowdown.

Water quenching of ash from incinerators is necessary to cool burning materials and prevent fires in ash storage containers. Makeup water is needed due to evaporation loss and ash absorption. This water will be supplied from boiler and cooling tower blowdown. This reclaiming will minimize use of EBMUD supplies.

Some water will also be needed for facility use, cleaning requirements, and start-up. Facility water requirements are summarized in Table 5-3.

Water Discharge

Wastewater discharges will include cooling tower blowdown, facility auxiliary uses and periodic ash quench tank discharges. All of the boiler blowdown and part of the cooling tower blowdown will be used for ash quenching. The remainder of the cooling tower blowdown and the wastewater from facilities and cleanup use will be discharged to the EBMUD sanitary sewer system. An estimate of the quality of cleanup water from the North Little Rock facility is shown in Table 5-4.

As now conceptualized, the cooling tower blowdown and the wastewater from facilities and cleanup use will not require pretreatment. Actual sampling from the constructed facility will be necessary to determine sewerage charges and permit compliance. Periodic removal of ash quenching water from the storage pit will occasionally be necessary to allow maintenance work. Frequency and volume is small compared to the continuous wastewater flows from the proposed facility; therefore, no problems are anticipated from sewer discharge. Regulatory authorities, however, might require quench water to be pretreated prior to discharge to the sewer or collected and transported to a liquid waste landfill for treatment and evaporation. Rainfall runoff from facility property will be directed to on site storm drains which will merge with other city stormwater flows and be discharged to the Bay.

Table 5-3

PROJECT WATER REQUIREMENTS & DISCHARGES

CATEGORY	EBMUD WATER, AVERAGE USAGE (Gallons/Year)	DISCHARGE/SEWER (Gallons/Year)	REMARKS
Boiler blowdown	982,000	0	Used for ash quenching - no discharge
Cooling tower makeup	67,000,000	12,400,000	53,600,000 evaporates; 700,000 used for ash quenching; remainder is sewered
Ash quenching	0	40,000*	Requirements met by reclaimed water - no continuous discharge
Start-up	50,000	0	5,000 required 10 times per year for boiler and tower startup
Facilities use	219,000	219,000	Restrooms, personal hygiene
Cleanup	438,000	438,000	Washdown of tipping floor

* Periodic removal of ash quenching pit water will be necessary for maintenance work. Pretreatment prior to discharge to sewer or offsite disposal in a liquid waste landfill might be required.

Table 5-4

NORTH LITTLE ROCK WEEKLY WASH WATER
POLLUTANT PARAMETER VALUES FOR MARCH, MAY & OCTOBER TESTS

Parameter	WASH WATER SOURCE				
	Tipping Floor			Residue Removal Equipment	Skid-Steer Loader
Date	3/22	5/25	10/10	3/21	3/23
pH		5.8	5.2	12.7	
Total solids (mg/l)		362	2020	5520	362
Settable solids (mg/l)		200	1070	19	510
Hardness $CaCO_3$ (mg/l)			295		
Fecal streptococcus (10^6/100 ml)	.0278	.48	5.3		.016
Total coliform (10^6/100 ml)	.726	.75	4.7		.605
Fecal coliform (10^6/100 ml)	.121	.007	.300		.009
COD (mg/l)		1880	2710		378193
BOD (mg/l)		1140	1780		126

Source: Reference 1

RESIDUES

Introduction

Municipal solid waste has an intrinsic ash content; some of the waste is noncombustible. Even the waste that will burn will not burn completely. The combustion of the fuel fraction will produce fly ash and bottom ash. Any processing of wastes and the screening of unprocessible wastes will also produce residues.

Ash

The fly ash, which rises with the hot gases of combustion, will be collected by the particulate air pollution control device (refer to Air Quality Section). The particulate thus collected is conveyed to an open-top bin which is replaced when necessary.

During the combustion of the fuel fraction, ash will collect on the floor of the incinerator. The bottom ash will be pushed along the floor to a collection hopper. This ash will then be water-quenched and conveyed to water-tight drop box containers which are periodically removed and replaced with empty ones.

Refuse combustion concentrates many of the heavy metal components of solid waste that can degrade groundwater. Under existing California regulations, therefore, the fly ash and bottom ash may require disposal at a Class I landfill site. A hazardous waste permit from the California Department of Health Services is required to haul hazardous wastes. Canvas tarps or metal lids for the drop boxes will be required to prevent any discharge during transport.

In an effort to generate additional information on this subject, the State Solid Waste Management Board sponsored a leachate test on ash generated from the resource recovery facility in Hamilton, Ontario (Reference 8). Due to the nonhomogeneity of the ash samples taken and the problems associated with simulating rainfall and landfill conditions in the laboratory, a strict interpretation of the study results could not be made. The Board's consultant recommended careful examination of the ultimate disposal of ash because a significant number of ash constituents were found to be readily soluble and potentially leachable in fairly high concentrations.

The Bureau of Mines has found by further testing that by preprocessing raw refuse into a RDF product, the heavy metal concentrations in boiler ash can be reduced (Reference 9). Cadmium, chronium, lead, manganese, silver, tin and zinc apparently come from the noncombustible components of refuse as well as from the combustibles. The removal of the noncombustible components of mixed municipal refuse by some preprocessing operation prior to use of the remainder for fuel will reduce concentrations of these seven (7) metals in the resulting boiler ash. Also, concentrations of antimony, cobalt, mercury, nickel and possible other metals may be reduced by separating the combustibles from the noncombustibles prior to burning.

Conversations with the California Department of Health Services and the San Francisco Bay Area Regional Water Quality Control Board have indicated that specifically approved tests on actual ash samples from the proposed facility will be necessary to obtain designation of ash as a nonhazardous material or to obtain approval for disposal in a Class II-1 site. Research and test results from other resource recovery facilities will not be sufficient unless specific preprocessing and/or combustion technologies are similar.

Approximately five years ago, the Central Sanitation District of Contra Costa County made a test burn of waste materials from a proposed resource recovery project. The project involved cofiring of sewage sludge and refuse derived fuel in a multiple hearth incinerator. The ash from this test burn, after undergoing analysis by approved state procedures, was given preliminary approval for disposal at Acme Fill's Class II-1 site. This site is located in Martinez.

The chemical analyses of the North Little Rock residue samples and the simulated leachate filtrate are presented in Tables 5-5 and 5-6. Gas chromatography, atomic absorption, infrared and spark source mass spectrometry analyses were used to detect the concentrations in Table 5-5. Chemical analyses of simulated leachate filtrate from a run with only distilled water (Test 1) and from a run with both distilled water and a phosphate buffer (Test 2) are presented in Table 5-6.

Unprocessible Waste and Process Residues

Residues which do not become part of the fuel fraction include certain floor-separated unprocessibles and "unders" from the trommel. Both of these fractions will be directed to open-top trailers. These residues are classified as nonhazardous and will be permitted disposal at Class II landfill sites.

Project residue quantities are presented in Table 5-7.

Table 5-7

PROJECT RESIDUE QUANTITIES

	QUANTITY (Tons/Year)
Incoming Refuse	137,500
Residue	
• Ash	9,800*
• Unprocessible Wastes	12,400
• Trommel Unders	46,800

* Does not include moisture from water quenching. Moisture content "after quenching" is approximately 32%.

Long-Term Disposal Sites

Industrial Tank's Benicia site (Class I) and Vasco Road site (Class II-1) are considered as alternative sites should West Contra Costa become unavailable for some reason. West Contra Costa Landfill in Richmond is the closest landfill considered to have the long-term potential of accepting project residuals over a 20-year planning period. Estimated current disposal costs are presented in Table 5-8. Because the cost of disposing of ash in Class II-1 sites is lower than in Class I sites, both cases are analyzed.

Table 5-5

NORTH LITTLE ROCK RESIDUE COMPONENT CONCENTRATIONS

COMPONENT	CONCENTRATION (Mg/g)*a
Decane	63.0
Undecane	19.0
Arsenic	1.96
Antimony	6.20
Sulfur	1000
Chlorine	100
Potassium	High*b
Phosphorus	High
Chromium	1000
Iron	High
Zinc	High
Copper	500
Fluorine	0
Tin	1000
Molybdenum	0
Barium	500
Lead	5000
Cadmium	High
Bromide	0
Boron	100
Mercury	0

*a Milligrams/gram
*b High - greater than 1000
Source: Reference 1

Table 5-6

NORTH LITTLE ROCK RESIDUE LEACHATE PARAMETER & COMPONENT VALUES

		Water Blank	Test 1	Phosphate Buffer Test 2
pH		5.52	8.65	6.05
Conductivity	umhos	2.78	185.00	2800
Alkalinity	mg/l	1.10	43.50	144
TKN	mg/l	6.95	5.25	11.6
Hardness	mg/l	2.00	70.00	ND
TOC	mg/l	3.10	5.70	2.2
Ortho-Phosphate	mg/l	0.005	0.025	1400
Total Phosphate	mg/l	0.01	0.044	1975
Sulfide	mg/l	0.002	0.002	ND
Chloride	mg/l	ND	0.71	12
Acidity	mg/l	5	ND	1841
Total Dissolved Solids	mg/l	1	80	5770
Ammonia as N	mg/l	0.216	0.183	0.23
COD		ND	ND	ND
Sulfate	mg/l	1.00	34.30	16.6
Bromide	mg/l	0.100	0.100	1.0
Fluoride	mg/l	0.058	0.099	.07
Boron	mg/l	0.1	0.1	127
Mercury	mg/l	0.1	0.1	-
Cadmium	mg/l	1	1	-
Antimony	mg/l	1.0	5.4	-
Lead	mg/l	1	1	-
Chromium	mg/l	1	1	-
Arsenic	mg/l	ND	ND	-
Cyanide	mg/l	-	-	.002
Phenols	mg/l	-	-	.005
MBAS	mg/l	-	-	0.12

ND - None detected
Source: Reference 1

Table 5-8

LONG-TERM DISPOSAL SITES FOR PROJECT RESIDUES

SITE	DESIGNATION	DISPOSAL COST ($/TON) Hazardous*a	DISPOSAL COST ($/TON) Nonhazardous	DISTANCE (One-Way)
Richmond	I, II-1	106*b, 40*c	7	12
Benecia	I	106*b	-	34
Vasco Road	II-1	40	6.85	45

*a Includes $1/ton surcharge from California Department of Health.
*b Class I - hazardous costs, $\$50/yd^3$, $950\ lb/yd^3$.
*c Class II-1 - hazardous costs.

NOISE

Construction

Daily noise levels at the proposed site will temporarily increase during the construction period as a result of truck traffic, excavation and building construction. Noise levels from powered construction equipment are dependent on the number of pieces of equipment in operation, their location, the type and age of equipment and other factors. As a mitigation measure to reduce temporary construction-related noise, noise mufflers and silencers could be installed on all engine intakes and exhausts. These noise levels are not considered significant because of the short duration of the construction period.

Regulations

Current regulations of the Occupational Safety and Health Administration (OSHA) do not allow exposure to noise levels greater than 90 dBA for a period exceeding eight (8) hours. Higher sound levels are permitted for shorter periods of time.

Facility

Compliance with all local, state, and federal regulations can be expected at the proposed facility. In a resource recovery plant similar to the proposed facility (North Little Rock, Arkansas), noise level measurements at no time exceeded 90 dBA on the A band (Reference 1). In-plant noise level measurements ranged from 79 dBA to 88 dBA. The noise levels at the plant boundaries were between 62 and 66 dBA. The principal noise generators include turbines and boilers, conveyors, high-speed fans and mechanical-draft cooling towers.

Collection vehicles and tractors hauling transfer trailers will generate additional noise at the site. Background noise levels, however, are significant because of the neighboring industries, the nearby presence of a Southern Pacific Railroad line and Interstate 80/Highway 17.

CHAPTER 6

FACILITY CONCEPTUALIZATION

GENERAL

The solid waste management facility conceptualized for the City of Berkeley has two major functions:

(1) To receive, process, recover (secondary materials) and convert (to energy) refuse.

(2) To transfer received refuse to a distant landfill in the event of extended downtime of the process and energy conversion equipment.

The energy conversion technology utilizes modular combustion/boiler units. Modular units do not require refuse processing to prepare the refuse as a combustion fuel, however, because of the high expense of ash disposal in the Bay Area (relative to general refuse disposal), processing to separate refuse noncombustibles (which would become part of the ash fraction) from combustibles is cost effective (refer to discussion on Front-End Process Technologies, Chapter 4).

The combustible fraction becomes the fuel product. Thermal energy in the combustion gases converts water to steam in the unit's boiler. The steam produced drives a turbogenerator to generate electricity. Extraction steam, at a lower pressure, is drawn from the turbogenerator to operate some of the facility's fans and is for sale to a nearby steam user. (Both steam and condensate return lines are provided.)

From the noncombustible fraction, ferrous metals and aluminum are removed with the remaining residues landfilled. Because of limited markets, stringent product specifications and the developmental nature of existing technology, a glass fraction is not recovered.

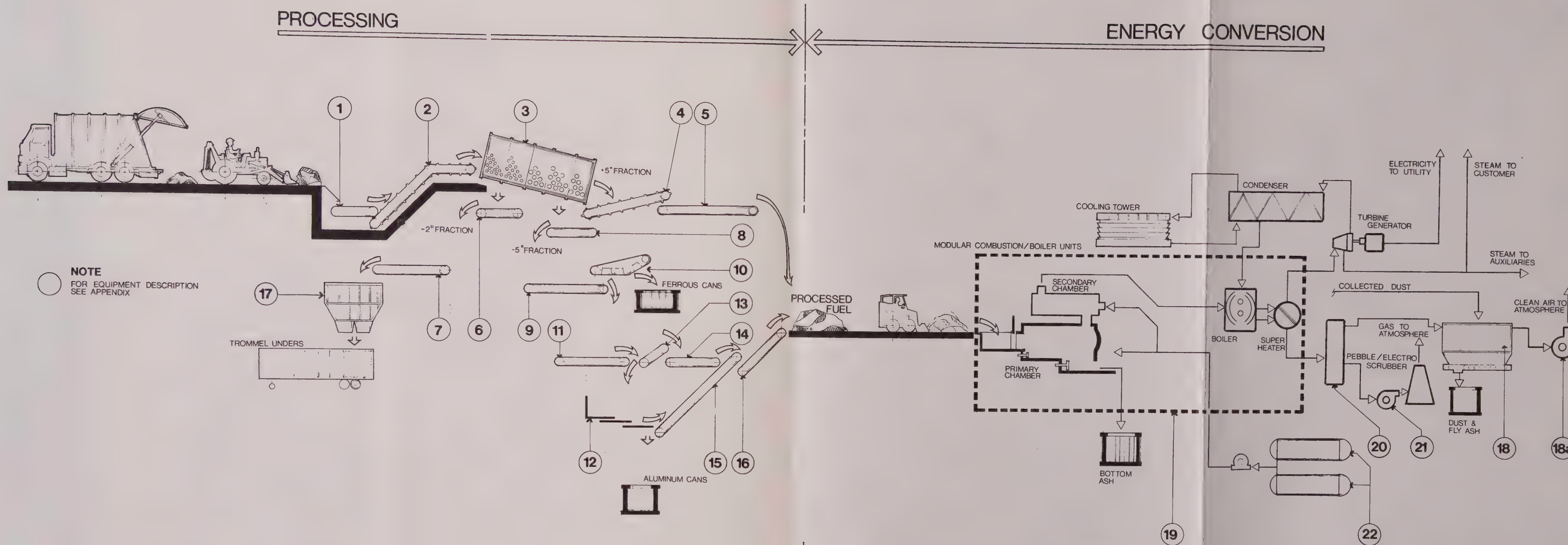
The facility is conceptualized with five 50 TPD modular combustion/boiler units, all interconnected. One unit will be used for standby and maintenance scheduling while the other units will be on line converting the fuel product to energy 24 hours per day, seven days per week.

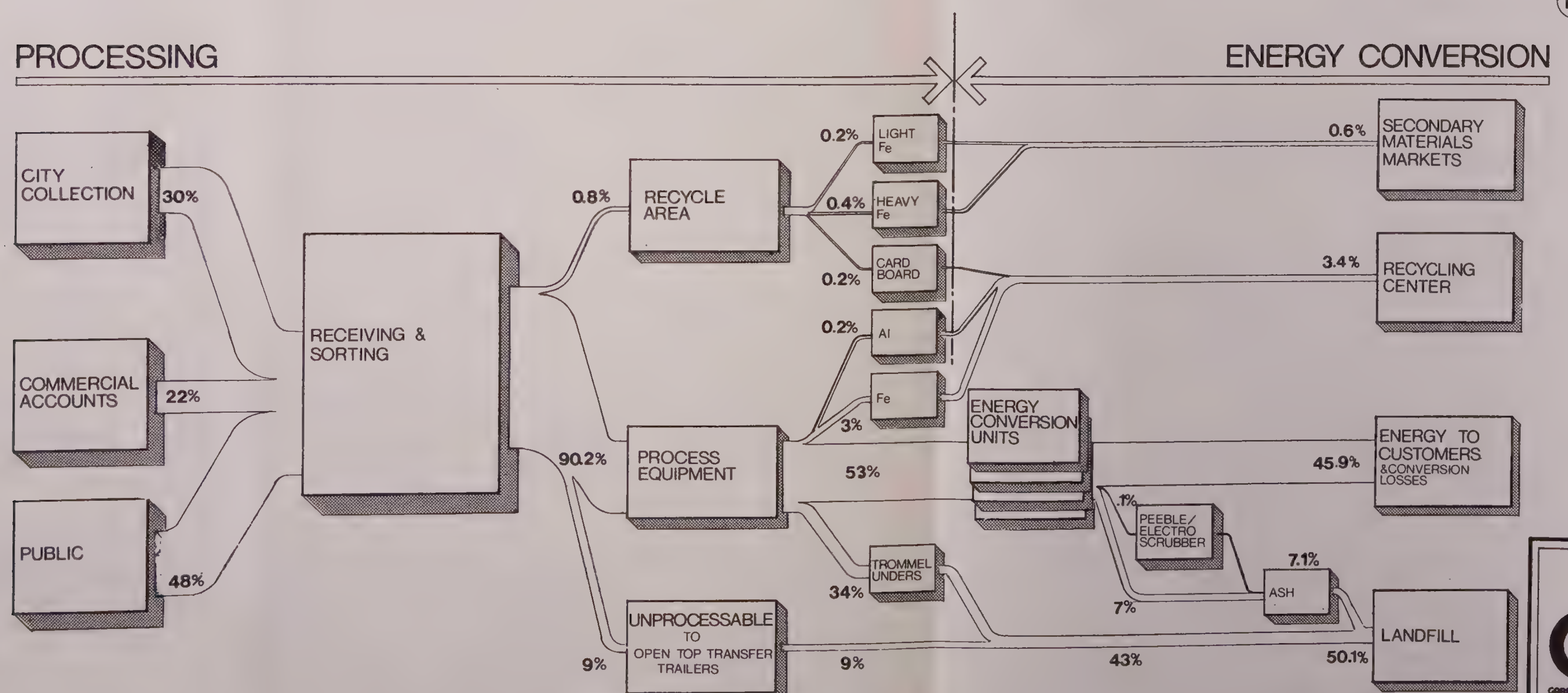
The front-end processing section of the facility operates on an eight hour per day, five day work week. The facility will, however, receive refuse on a seven day per week schedule.

The processing operation developed for the Berkeley facility consists of trommeling, mechanized ferrous metal and manual aluminum metal recovery. A process flow and materials balance diagram is presented in Figure 6-1.

FACILITIES DESCRIPTION

MMR is transported to the facility by City packer collection vehicles, commercial refuse haulers and private vehicles (e.g., auto, pickups, trailers, etc.). All vehicles enter the site at the Scale House which is located at the north end of Second Street (refer to site plan, Figure 6-2). Two queuing lanes are provided: one for City and commercial vehicles and one for the general public. Signal lights, operated by the Scale House attendant, regulate the flow of traffic into the site.





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FLOW DIAGRAM
MATERIALS
BALANCE

CONCEPTUAL DESIGN

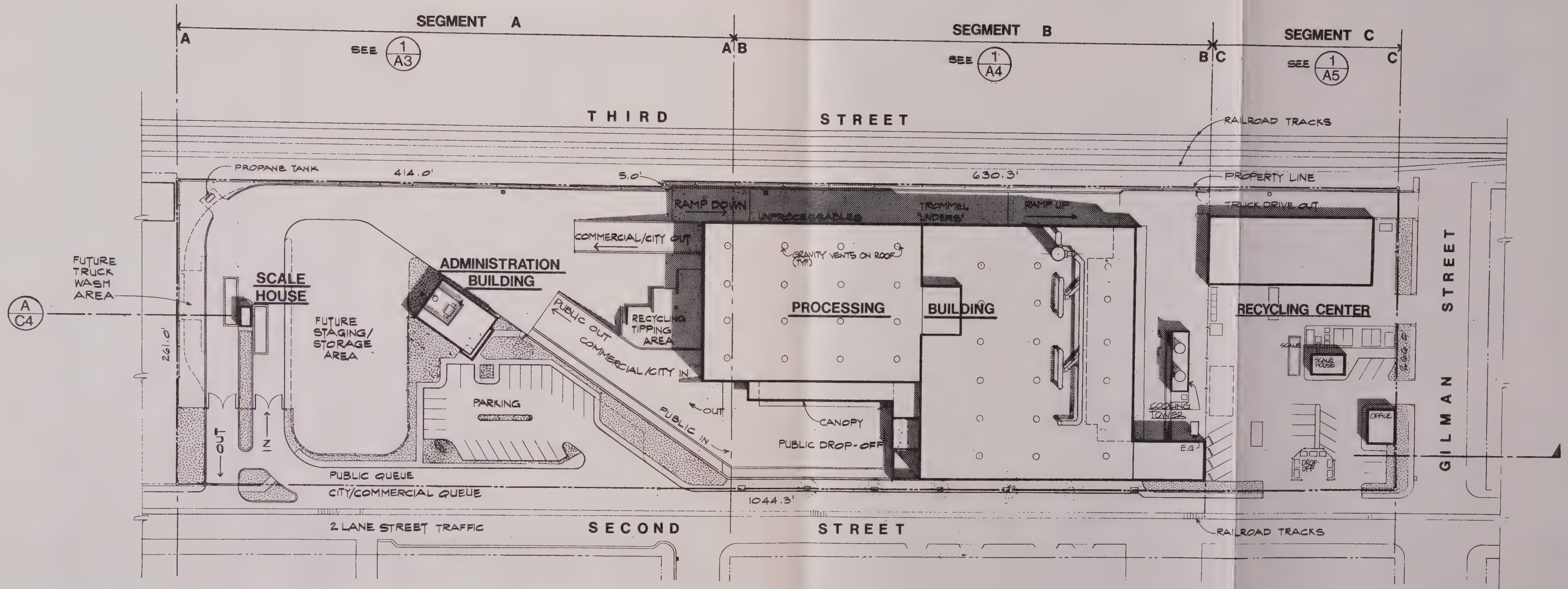
SOLID WASTE
MANAGEMENT CENTER

SECOND AND GILMAN STREETS

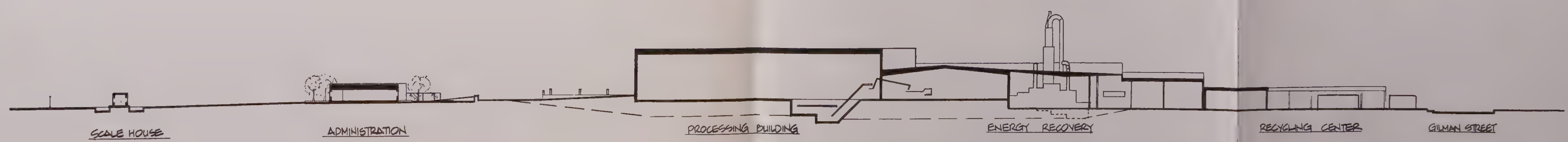
CITY OF BERKELEY
DEPARTMENT OF PUBLIC WORKS

FIGURE

6·1



1/C4 SITE PLAN



A/C4 SITE SECTION

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SITE PLAN, ROOF PLAN

CONCEPTUAL DESIGN
SOLID WASTE MANAGEMENT CENTER
SECOND AND GILMAN STREETS
CITY OF BERKELEY
DEPARTMENT OF PUBLIC WORKS

FIGURE
6·2

All of the City collection vehicles and commercial haulers (capable of dumping their loads in a relatively short period of time) enter the enclosed Processing Building and discharge their loads onto a concrete tipping floor. The general public and some commercial vehicles using the facility are accommodated by openings in the west side of the building. This is done in an effort to reduce traffic congestion inside the building where the larger trucks and other mobile equipment are maneuvering. Refuse is dumped through the openings over a concrete retaining wall onto the tipping floor. Ten dumping stalls are provided. Before entering the site at the Scale House, the general public is provided the opportunity to drop off recyclables at the Recycling Center which is located at the south end of the site.*

On the tipping floor, unprocessible wastes (e.g., large tree stumps, oversized furniture, gypsum, etc.) designated recyclable materials (i.e., cardboard, white goods, and heavy and light ferrous metals) and potentially explosive or hazardous wastes (e.g., partially filled cans of paint thinner) are segregated by manual labor or by a front end loader from the processible material and directed to their respective trailers (a 90-cubic-yard, open-top, live-bottom for unprocessibles) or drop boxes (for cardboard, white goods, heavy and light ferrous metals and explosive/hazardous wastes).

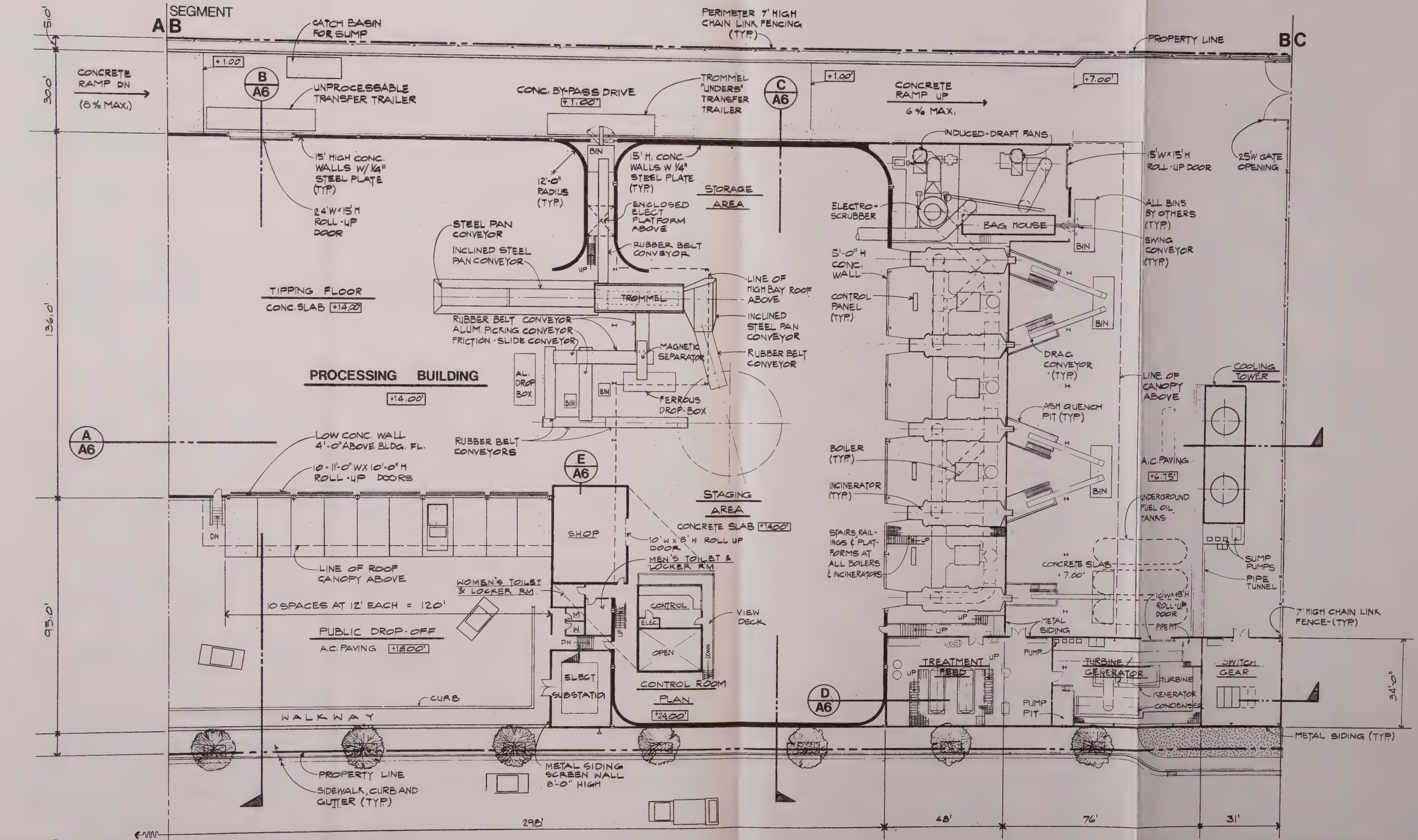
From the tipping floor, the front-end loader is used to feed the processible materials to a steel pan apron conveyor (refer to equipment layout, Figure 6-3). The processible refuse is tranferred from the apron conveyor to an inclined, steel pan, cleated conveyor which travels faster than the apron conveyor, giving a tumbling and leveling action to the refuse. This inclined conveyor levels off to a horizontal position for ten (10) feet, at which point it feeds a trommel, a rotating screen declined about three to five degrees. This trommel has two sections of different sized holes. The first section, approximately 40% of its length, has two-inch diameter holes while the remainder has 4.75-inch diameter holes. Refuse undergoes a tumbling, tearing action as it progresses through the trommel.

Approximately 34% of the processible refuse drops through the two-inch holes of the first section. The composition of this fraction consists mostly of glass, debris and other inerts with a small amount of combustibles. This fraction falls on a rubber belt conveyor and is transferred to a distribution hopper which discharges into a 90-cubic-yard open-top, live-bottom trailer destined for the landfill. This hopper also provides storage during trailer switching.

Approximately 23% of the processible refuse drops through the 4.75-inch holes in the remainder of the trommel. The composition of this fraction is mostly ferrous, aluminum, combustibles and a small amount of inerts. This fraction falls on another rubber belt conveyor and is passed under a magnetic separator where the ferrous content is removed and deposited in a roll-off container.

The remainder of the refuse that passes the magnetic separator is transported via a rubber belt conveyor to a friction slide conveyor which, due to its adjustable speed and inclination, causes the aluminum can stock and some heavy combustibles to fall back down onto a slip-stick picking conveyor. Pickers stationed on both sides of this conveyor will remove the aluminum by hand and place it in small bins. As the small bins fill, they are rolled and emptied into a 30-cubic yard drop box utilizing the bucket of the front-end loader.

* *Note: The cost for the Recycling Center is not included in the cost estimates presented in this report. The Recycling Center is being designed and built by others.*



SECOND STREET

2 - LANE TRAFFIC

NOTES

ELEVATIONS AS INDICATED ARE TAKEN AS BEING ABOVE MEAN SEE LEVEL

FOR OTHER SITE UTILITIES SEE DRAWINGS M-1, M-2, E-3 AND E-4.

1/A4 SITE PLAN SEGMENT B

8 0 8 24 40

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SEGMENT B
PLAN
PROCESSING
BUILDING

CONCEPTUAL DESIGN

SOLID WASTE
MANAGEMENT CENTER

SECOND AND GILMAN STREETS

CITY OF BERKELEY
DEPARTMENT OF PUBLIC WORKS

FIGURE 6-3

The remainder of the refuse from the picking conveyors is joined with the carry-over portion of the friction slide conveyor, mostly light combustibles, conveyed by rubber belt conveyor and discharged onto the concrete staging-storage floor.

The throughput of the trommel (plus 4.75 inch material), the majority of which is combustible, is transferred to another inclined cleated conveyor which feeds a rubber belt discharge conveyor. This rubber belt conveyor, traveling at a higher speed, discharges the refuse onto the staging-storage floor.

At this point, a front-end loader either stockpiles the fuel product or feeds the modular unit charge boxes. The staging-storage area has a capacity of four days of processed refuse.

From their charge boxes, the fuel product is fed into a primary chamber where it is burned under controlled air conditions. The resulting gases are passed through a second chamber, where excess air is injected to complete combustion. Auxiliary fuel is required in minimal quantities to maintain proper combustion temperatures. Combustible particulate matter burns off, and the hot gases are passed through a waste heat boiler to produce steam.

Steam is piped to a turbogenerator, then through a condenser in which heat transfer is accomplished by cooling tower water. The condensate is pumped back to the boiler. Makeup water is required for the boiler because of blowdown losses. Makeup water is subjected to a chemical and demineralization treatment before introduction to the boiler. Makeup water is also required for the cooling tower because of evaporation and blowdown losses. Cooling tower makeup water is subjected to chemical treatment. The flue gas train includes fans, an electro-scrubber, a baghouse shared with the dust collection system and an exhaust stack. Dump stacks handle combustion gases in the event of boiler or power failure. Dump stack gases are passed through a cooling zone (water spray) and then channeled to the electro-scrubber. Residue remaining after combustion is dropped into an ash pit where it is water quenched and mechanically conveyed to a storage drop box to await truck transport to a landfill.

The electricity generated will be produced at a maximum of 12,400 volts, 3 phase, 60 Hz. Generated electricity can be used for both in-plant processing and/or export as an energy product. Power will be provided at 13,800 volts to the electrical distribution network for transformation (if required) and transmission.

The modular combustion/boiler units utilize No. 2 fuel oil for start-up, temperature maintenance and as back-up fuel should the supply of refuse be cut-off. Sufficient on-site storage has been provided for a minimum of five (5) days of operating only on fuel oil.

Complementing the process and combustion systems are a water supply with various hose bib stations, compressed plant and instrumentation air supply, a sprinkler fire protection system, a backup diesel generator (to provide for safe shutdown of the facility in the event of a power failure) and a dust collection system. The dust collection system consists of dust hoods over the trommel, including infeed and discharge chutes; and at conveyor transfer points, ducting from the hoods to a baghouse and an induced draft fan with discharge stack.

A shop, change room and control room are provided. The control room has a graphic display board, as well as the monitoring and recording devices for the process and combustion system. The location of the control room provides a vantage point sufficient to monitor activities of the public drop off, receiving/processing area and the combustion staging-storage area.

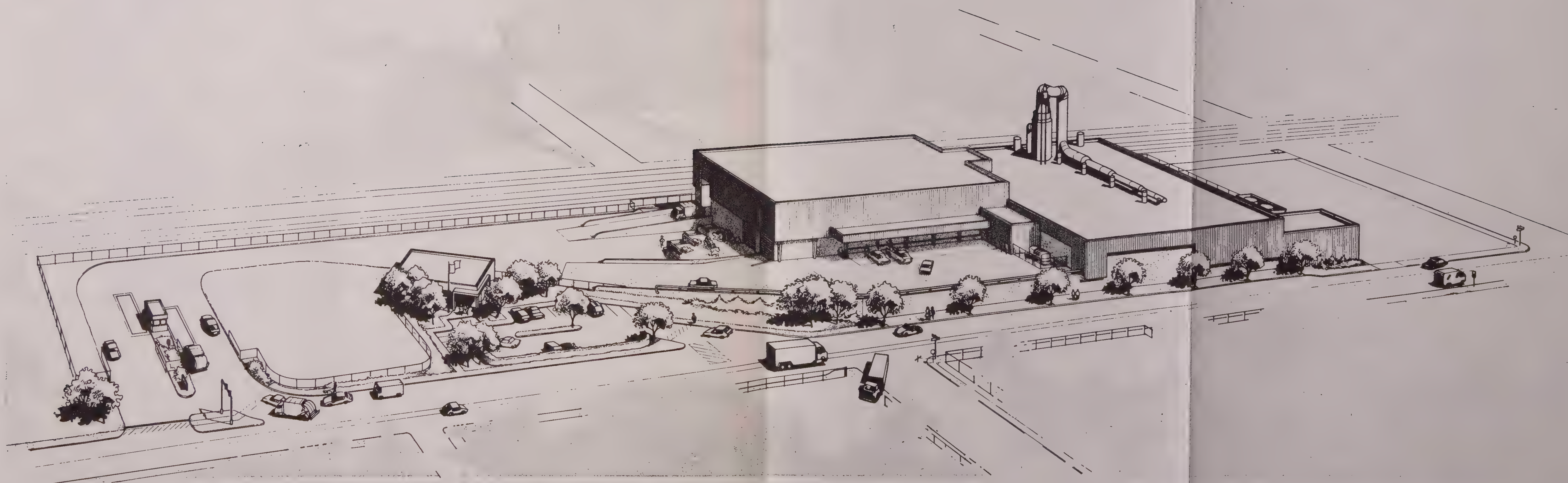
Recovered aluminum and cardboard are stored in drop boxes which are transferred to the adjacent Recycling Center for marketing. Plans for the Recycling Center include an aluminum shredder and paper baler. Recovered ferrous metals, also stored in drop boxes, are transported directly to market.

A perspective rendering of the facility is presented in Figure 6-4. A complete set of facility drawings and outline specifications are provided in the appendix.

An energy balance diagram for the facility is illustrated in Figure 6-5. The diagram, which is on a per ton basis, indicates that the facility is a net energy producer. The efficiency of converting refuse from a nonusable energy form to steam and electricity is 19%. As a comparison, the efficiency of a large scale PG&E coal-fired facility producing only electricity is approximately 30% to 35%.

BASIC DESIGN PARAMETERS

Parameters used to conceptualize the facility are listed in Table 6-1.



SITE PERSPECTIVE

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SITE PERSPECTIVE

CONCEPTUAL DESIGN

SOLID WASTE MANAGEMENT CENTER

SECOND AND GILMAN STREETS

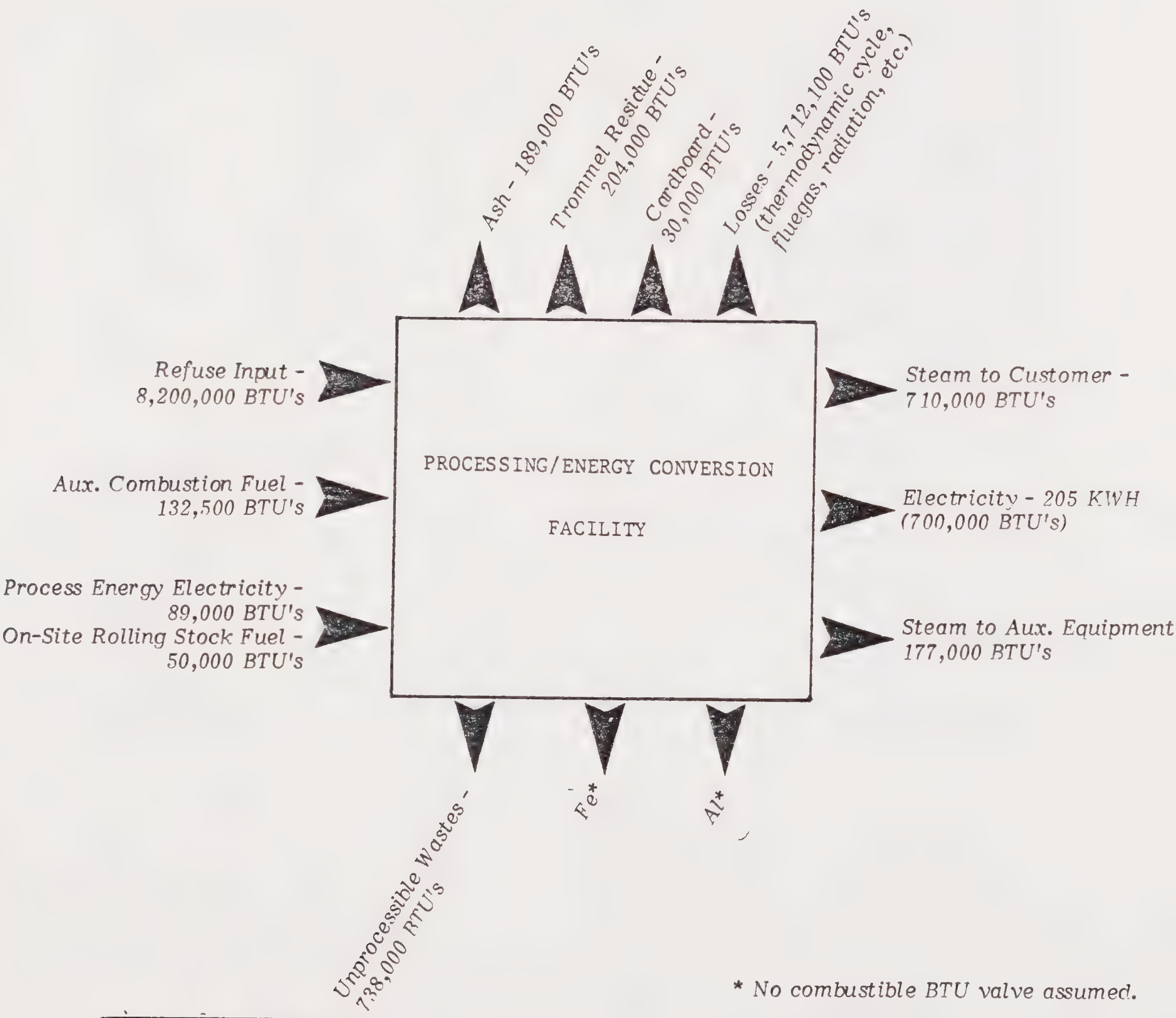
CITY OF BERKELEY

FIGURE 6·4

Table 6-1

BASIC DESIGN PARAMETERS

Item	Value
Quantity	137,500 tons/year
Trommel Split	
• -2" fraction	34%
• +2"-4 3/4" fraction	23%
• +4 3/4" fraction	43%
Unprocessible	9%
Designated Recyclables	0.8%
Fuel Product	53%
Fuel Product Moisture Content	30%
Fuel Product Heating Value BTU's (Moisture Free Basis)	8400/lb.
Ash Content of Fuel Product (As Received)	13%
Air Pollution Control Removal (Fly Ash)	0.1%
Boiler Efficiency	60%
Steam to Turbine/Generator Set	
• Output	3.3 lb./lb. of refuse fuel
• Pressure	600 psig
• Temperature	550^{o}F
Turbine Steam Rate (Cogeneration)	
• Full Expansion	14 lb. steam/Kwh
• Extraction	50 lb. steam/Kwh
Ferrous Recovery	75%
Aluminum Recovery	65%
Steam to Cal Ink	
• Pressure	150 psig
• Average Hourly Demand (24 Hrs/D; 5 D/Wk)	15,000 lb.
Facility Availability	85% (310 D/Yr)



* No combustible BTU valve assumed.

BROWN, VENCE & ASSOCIATES
Energy and Environmental Engineers

Energy Balance Diagram

FIGURE 6-5

CHAPTER 7

ECONOMIC ANALYSIS

SOLID WASTE MANAGEMENT ALTERNATIVES

Economics are presented on the following solid waste management alternatives:

- *Transfer and Haul*
- *Transfer and Haul with Mechanical Materials Recovery*
- *Materials and Energy Recovery - Cogeneration (Steam and Electricity)*
- *Materials and Energy Recovery - Electricity only*

The mechanical materials recovery system proposed for the transfer and haul alternative is the same system as previously (Chapter 6) conceptualized for the energy recovery facility. The system consists of various conveyors, trommel and a ferrous magnetic separator. Aluminum is manually picked off a vibrating conveyor. Refer to Figure C5 in Appendix I for site plan of alternatives.

In the cogeneration alternative, 20% of the steam generated is assumed sold to Cal-Ink. The remaining steam is used internally or used to generate electricity which is assumed sold to PG&E.

CAPITAL COSTS

Capital costs for the four solid waste management alternatives are presented in Table 7-1. Costs include site preparation, buildings, equipment, construction, engineering, finance and escalation (at 12% per year) to 1984, the mid-construction period.

PERSONNEL REQUIREMENTS

Table 7-2 lists the personnel required by a private operator to operate the four solid waste management alternatives by job classification. For the transfer and haul alternatives, the staffing provides for an eight hour per day, seven day per week operation except for the process line which will operate only five days per week. For the energy recovery alternatives, the staffing provides an eight hour per day, five day per week operation for the process line and a 24 hour per day, seven day per week operation for the combustion area. Energy recovery facilities are open to receive refuse seven days per week.

OPERATING & MAINTENANCE COSTS

Table 7-3 lists the operating and maintenance costs of the four solid waste management alternatives. Costs are escalated to 1985 (first year of operation) at 10% per year. Cost assumptions are presented in Appendix K. The O&M costs are based on an annual tonnage of 137,500 less 15% (allotted for plant unavailability) which is assumed transferred, hauled and landfilled during plant downtime.

The cost sensitivity of combustion ash disposal is significant. The cost reported in the table reflects an estimated Class II-1 (West Contra Costa) charge at $40 per ton (1980). If an estimated Class I disposal (West Contra Costa) charge at $106 per ton (1980) is required, the 1985 O&M costs would increase by approximately $1,427,000 or $10.40 per incoming ton.

Table 7-1

CAPITAL COSTS (1984) - SOLID WASTE MANAGEMENT ALTERNATIVES

COST ITEM ($1,000)	TRANSFER & HAUL: w/o Mech. Separation	TRANSFER & HAUL: w/Mech. Separation	MATERIAL & ENERGY RECOVERY: Cogeneration	MATERIAL & ENERGY RECOVERY: Electricity Only
Site Preparation	$518	526	577	572
Buildings & Foundations	764	908	1,831	1,831
Rolling Stock	1,012	934	692	692
Spare Parts	54	100	447	447
Equipment				
Process Line	—	989	989	989
Combustion/Boiler Units	—	—	5,253	5,253
Turbine/Generator Set	—	—	741	741
Air Pollution Control	—	77	908	908
Cooling Tower	—	—	309	309
Scales	51	51	51	51
Backhoe/Tamper	25	25	—	—
Fuel Oil Storage	—	—	56	56
Mechanical	131	206	654	333
Electrical	107	325	1,053	1,053
Subtotal (Base Capital Cost)	$2,662	$4,141	$13,561	$13,232
Contingency (10%)	266	414	1,356	1,323
Division I (General Cond.)*a	266	414	678	662
Escalation 60%	1,597	2,485	8,137	7,939
Subtotal	$4,791	$7,454	$23,732	$23,156
Performance/Surety Bond*b	38	60	166	162
Engineering*c	479	745	1,187	1,158
General Contractor Fee*d	383	596	1,424	1,389
Finance Costs @ 20%*e	-	-	3,560	3,473
Working Capital (5%)	240	373	1,187	1,158
TOTAL CAPITAL COSTS	$5,931	$9,228	$31,256	$30,496

*a Transfer (10%); Energy Recovery (5%)
*b Transfer (0.8%); Energy Recovery (0.7%)
*c Transfer (10%); Energy Recovery (5%)
*d Transfer (8%); Energy Recovery (6%)
*e It is assumed that procurement of the transfer station would not be with bonds but with capital accumulated in the ...y's ...se ...osal ...elo... ...nt F...

Table 7-2

PERSONNEL REQUIREMENTS - SOLID WASTE MANAGEMENT ALTERNATIVES

POSITION	ANNUAL SALARY (1980)	NUMBER			POSITION COSTS		
		Transfer w/o Sep.	Transfer w/Sep.	Energy Recovery	Transfer w/o Sep.	Transfer w/Sep.	Energy Recovery
Operations Manager	$34,000	1	1	1	$34,000	$34,000	$34,000
General Foreman	27,000	-	-	1	-	-	27,000
Power Plant Operator	24,000	-	-	5	-	-	120,000
Mechnanic/Electrician	24,000	1	1	3	24,000	24,000	72,000
Rolling Stock Operators							
Loaders	21,000	3	3	6	63,000	63,000	126,000
Residual Disposal	21,000	10	9	5	210,000	189,000	105,000
Control Operator	20,000	-	-	1	-	-	20,000
General Maintenance	14,000	-	-	2	-	-	28,000
Process Operator	14,000	-	1	1	-	14,000	14,000
Station Operator	14,000	1	1	-	14,000	14,000	-
General Laborer	12,000	2	3	2	24,000	36,000	24,000
Scale House Clerk	10,000	2	2	2	20,000	20,000	20,000
Casual Laborer	9,000	-	4	4	-	36,000	36,000
SUBTOTAL		20	25	33	$389,000	$430,000	$626,000
Fringe Benefits @ 32%					125,000	138,000	200,000
SUBTOTAL					$514,000	$568,000	$826,000
Escalation to 1985 @ 60%					308,000	341,000	496,000
TOTAL		20	25	33	$822,000	$909,000	$1,322,000

Table 7-3

ANNUAL O&M COSTS (1985) - SOLID WASTE MANAGEMENT ALTERNATIVES

COST ITEM ($1,000)	TRANSFER & HAUL		MATERIALS & ENERGY RECOVERY	
	w/o Mech. Separation	w/Mech. Separation	Cogeneration	Electricity Only
Labor	$514	$568	$826	$826
Maintenance Expendibles*[a]	35	76	146	146
Electric Power*[a]	10	57	136	136
Rolling Stock (In-Plant)	47	47	98	98
Auxiliary Fuel (Combustion)*[a]	—	—	122	122
Haul and Disposal*d				
Raw Refuse*[b]	1,306	692	196	196
Unprocessible Wastes*[a]	—	126	107	107
Trommel Unders*[a]	—	430	366	366
Ash*[a*c]	—	—	527	527
Insurance	21	36	78	76
Sinking Fund (Minor Equipment)	11	62	270	270
Subtotal	$1,944	$2,094	$2,872	$2,870
Contingency @ 10%	194	209	287	287
Escalation @ 60%	1,164	1,256	1,723	1,722
TOTAL	$3,304	$3,559	$4,882	$4,879

*a Costs based on 85% (System Availability Factor) of 137,500 TPY.

*b For energy recovery alternatives 15% of 137,000 TPY is assumed transferred and hauled due to system downtime.

*c Costs presented reflect Class II-1 disposal charges of $40 per ton (1980). Assuming Class I disposal of $106 per ton (1980), the 1985 O&M increase for haul and disposal would be $1,427,000. On an incoming tonnage basis, the increase is approximately $10.40 per ton.

*d Costs presented reflect estimated charges at West Contra Costa Landfill. O&M costs would increase approximately 10%-15% or $1.00-$1.50/ton, if disposal occurred at Vasco Road (Class II-1) and Benecia (Class I)

Table 7-4

ANNUAL REVENUES (1985) - SOLID WASTE MANAGEMENT ALTERNATIVES

	TRANSFER & HAUL		MATERIALS & ENERGY RECOVERY	
COST ITEM ($1,000)	w/o Mech. Separation	w/Mech. Separation	Cogeneration	Electricity Only
Secondary Materials				
Cardboard @ $36/ton	$10	$10	$10	$10
Heavy Ferrous @ $70/ton	38	38	38	38
Light Ferrous @ $30/ton	8	8	8	8
Aluminum @ $425/ton	—	100	100	100
Ferrous Cans @ $30/ton	—	105	105	105
Subtotal*a	56	261	261	261
Energy*b				
Electricity @ $0.062/Kwh	—	—	1,500	1,700
Steam @ $6/1000#	—	—	477	—
Subtotal	—	—	1,977	1,700
Escalation @ 100%*b	—	—	1,977	1,700
TOTAL	$56	$261	$4,215	$3,661

*a Due to the cyclical nature of the secondary materials market, 1985 prices were obtained by holding 1980 prices constant.

*b 1980 energy prices escalated at 15% per year.

Table 7-5

ALTERNATIVE COST/REVENUE SUMMARY
($1,000)

Alternatives	(1) Capital Costs (1984)	(2) Standard Amortization *a	(3) O&M Costs (1985)	(4) Total Costs (1985) (2)+(3)	(5) Revenue (1985)	(6) Net Cost (1985) (4)-(5)
Transfer and Haul						
w/o Mechanical Separation	$5,931	$593	$3,304	$3,897	$56	$3,841
w/Mechanical Separation	9,228	923	3,559	4,482	261	4,221
Materials and Energy Recovery						
Cogeneration (Class II-1)	31,256	3,438	4,882	8,320	4,215	4,105
Electricity Only (Class II-1)	30,496	3,355	4,879	8,234	3,661	4,573
Cogeneration (Class I)	31,256	3,438	6,309	9,747	4,215	5,532
Electricity (Class I)	30,496	3,355	6,306	9,661	3,661	6,000

*a
- Transfer and Haul - 20 years; 8% (cities opportunity cost)
- Energy Recovery - 20 years; 9% (CPCFA financing)

If the West Contra Costa Landfill at Richmond is unavailable, then disposal of project residuals at more distant landfills will be necessary. Assuming the use of Vasco Road (Class II-1) and Benecia (Class I) landfills as alternative sites, the 1985 O&M costs would increase by approximately $1.00 to $1.50 per ton, depending on the solid waste management alternative. Complete costs can be calculated from data presented in Appendix K.

Discussions have taken place with Air Research, Inc., concerning their patented process for converting solid waste residuals into concrete-like products. Since 1970, Air Research has been developing an adhesive which would bind solid waste into a concrete-like slurry from which a multitude of useful products could be formed (e.g., accoustical blocks). At present, the process has only been demonstrated on a laboratory scale. The firm is, however, actively marketing the process to existing and planned resource recovery projects. For purposes of a planning cost estimate, the firm suggested using 60% of the haul and disposal costs associated with the project's residuals. This estimate provides significant savings in ash disposal should ash require Class I disposal. It is, however, greater than Class II-1 costs which are estimated at approximately 40% of Class I haul and disposal costs.

REVENUES

The revenues for the four solid waste management alternatives are presented in Table 7-4. Energy revenues are escalated to 1985 at 15% per year. Due to the cyclical nature of the secondary material markets, secondary material revenues are not escalated but held constant.

Because of energy recovery system availability of 85%, a credit for only 85% of the potential revenues is taken. Revenue consumptions are presented in Appendix K.

SUMMARY OF ALTERNATIVE COSTS & REVENUES

Costs and revenue data for the four solid waste management alternatives presented earlier are summarized in Table 7-5.

LIFE CYCLE COST ANALYSES

The purpose of a life cycle cost analysis is to project costs and revenues of solid waste management alternatives over their useful life. The net cost of the alternatives can then be computed for each year of project life. A comparison of project net life cycle costs yields the most economically feasible alternative.

A financing computer model developed by the State Solid Waste Management Board was the vehicle used to project the life cycle costs of each scenario under consideration. The model incorporates amortization of capital, product revenues and levelized debt service.

For the purposes of this study, energy recovery capital is amortized over 20 years at 9%, transfer and haul capital is amortized over 20 years at 8%, the city's opportunity cost of using the Refuse Disposal Development Fund monies for facility procurement. O&M costs are escalated at an assumed long-term inflation rate of 8%. Energy revenues are escalated at the inflation rate plus an assumed real differential escalation rate of 2.1%. Secondary materials revenues are not escalated due to the cyclical nature of their markets.*

Standard debt service requires the repayment of debt (principal) plus stipulated interest in equal installments over the life of the loan. A levelized debt service requires no principal repayment in the early years of project life - only interest. Principal payments begin 5-10 years after project start up and are of a sufficient magnitude to repay the debt within the remaining years of loan life. A levelized debt service, therefore, serves to lower resource recovery costs in the early years of project life and increase costs in later years.

* *State Energy Resource Conservation and Development Commission Newsletter, July 1980.*

TRANSFER & HAUL vs. ENERGY RECOVERY COSTS

Table 7-6 displays the life cycle costs of the four solid waste management alternatives.

Energy recovery alternatives are less expensive on both a cost per ton and total life cycle cost basis. Costs for energy recovery alternatives reflect Class II-1 disposal for ash.

If Class I disposal is required for ash, transfer alternatives are initially less expensive. However, in later years, energy recovery becomes less expensive. The breakdown point is between 4-8 years. On a total life cycle cost basis, energy recovery alternatives are equal to or less expensive.

Table 7-6

LIFE CYCLE COSTS - SOLID WASTE MANAGEMENT ALTERNATIVES*a
(NET SYSTEM COSTS PER TON)*b

Alternatives	Years 1985	1994	2003	Life Cycle Costs*c (1985 $)
Transfer and Haul				
w/o Mechanical Separation	27	51	103	515
w/Mechanical Separation	29	56	113	559
Materials and Energy Recovery				
Cogeneration (Class II-1)	22	19	23	215
Electric Only (Class II-1)	25	28	44	307
Cogeneration (Class I)	32	39	65	423
Electricity Only (Class I)	36	48	86	515

*a For the alternatives, levelized debt service is utilized. Cost per ton figures will, therefore, be lower than would be derived using numbers reported in Table 7-5.
*b Costs are based on an annual tonnage of 137,500.
*c Cummulative cost per ton.

The ranking of project alternatives on a total life cycle basis is as follows:

Alternative	*Total Life Cycle Costs (1985)*
Materials and Energy Recovery	
Cogeneration (Class II-1)	*$29,600,000*
Electricity Only (Class II-1)	*$42,200,000*
Cogeneration (Class I)	*$58,200,000*
Electricity Only (Class I)	*$70,800,000*
Transfer and Haul	
Without Mechanical Materials Separation	*$70,800,000*
With Mechanical Materials Separation	*$76,900,000*

The Federal Department of Energy is considering subsidizing programs with price supports. Proposed regulations have been issued on the DOE Price Support Programs. Under Section 20(b)(1) of the Federal Nonnuclear Energy Research and Development Act of 1974 (PL95-238 & PL93-577), the DOE is authorized to provide Federal financial assistance to selected municipalities in the form of grants, contracts, price supports, cooperative agreements or any combination thereof. The price support is designed to provide short term (5 year) direct cash subsidies to projects which convert waste to energy on the basis of the type and quantity of energy produced. While this program is currently limited in scope, the potential for funding is relatively large and could provide assistance necessary to make a project viable in its early years. Stronger price support legislation is currently being considered by Congress (S. 1934).

The costs presented for the energy recovery alternatives do not take into account the profit and tax consequences of private ownership and operation. Tax benefits such as investment and energy tax credits could be passed onto the City in the form of lower disposal charges. However, a portion of all of the credits might be required to meet profit requirements in the early years of project operation. The exact effect of tax credits and profit requirements on the costs to the City cannot be determined at this time.

CHAPTER 8

PERMIT & APPROVAL REQUIREMENTS

INTRODUCTION

The regulatory restraints on the proposed project are numerous and complex. This chapter presents an identification of all responsible agencies and a brief description of their scope of authority, permit procedures and approximate times required to obtain each permit/approval, and estimates of preapplication, preconstruction and total permitting time requirements. Agencies with regulatory authority are identified in Table 8-1; an approximate schedule for obtaining permits/approvals is presented in Figure 8-1.

AGENCY CONSTRAINTS

Federal

U.S. Corps of Engineers (COE): The COE will not require any permits for the proposed project. However, it is proposed that facility runoff be discharged to the San Francisco Bay (under COE jurisdiction) through the existing storm drainage system. It is advisable that a letter be obtained from COE stating that the project, due to the Bay discharge, has been reviewed and that no COE action is required.

U.S. Fish and Wildlife Service: Solid waste management facilities do not require permits from the U.S. Fish and Wildlife Service. However, the Service may review plans and comment where there are potential impacts on fish and wildlife. They may also suggest mitigation measures.

U.S. Environmental Protection Agency (EPA) Region IX: Solid waste management facilities must meet all applicable standards set by EPA. Except for the Prevention of Significant Deterioration (PSD) Permit, application for which must be made directly to EPA, all measures are administered by a State or local agency.

Department of Energy, Federal Energy Regulatory Commission (FERC): The responsibilities of FERC include the administration of the Public Utilities Regulatory Policies Act (PURPA) of 1978, provisions of which can exempt the proposed project from specific Federal and State laws (see State Public Utilities). A qualifying project may obtain an exemption in either of two ways:

- *By self-determination that the project meets all qualifying specifications in Sections 201 and 210 of PURPA; no further action is required.*

- *By applying for a certification of exemption under the procedures outlined in the Federal Register of March 20, 1980, Vol. 45, No. 56, Section 292.207, p. 17959. The certification may be beneficial in aspects of the procurement process.*

In addition, ". . . Commission has provided a requirement. . . that an electric utility is not required to purchase electric energy from a facility with a design capacity of 500 kilowatts or more until 90 days after the facility notifies the utility that it is a qualifying facility, or 90 days after the facility has applied to the Commission. . ." (Reference 11) for certification of status as a qualifying facility. As this provision is applicable to the proposed project, it would be advisable not only to apply for a formal certification from FERC, but also to notify the electric utility, Pacific Gas and Electric Company.

State

California Air Resources Board (ARB): Solid waste management facilities with air emissions must meet standards and limitations necessary for the attainment of State and National Ambient Air Quality Standards. ARB performs in a review and advisory capacity in the Regional Air Pollution Control District permit process. ARB comments and suggestions may be incorporated into permit conditions.

State Department of Fish and Game: Proposed solid waste facilities are reviewed by Fish and Game to determine their impact on fish and game resources. Mitigating measures may be recommended.

State Department of Health Services: This department is responsible for regulating the handling, processing and disposal of hazardous wastes. Solid residuals (fly and bottom ash) are classified as hazardous waste; thus, ash transport and disposal are subject to Department regulations and will be assessed a surcharge of $1.00 per ton of ash disposed. Storage of ash for a period longer than sixty (60) days would necessitate application for a hazardous waste facilities permit. Haulers of hazardous wastes must register with the Department.

State Energy Resource Conservation and Development Commission (CEC): Energy generating facilities producing less than 50 megawatts (MW) fall below the minimum requirement for direct supervision/certification. The proposed project would not require any permit or review from CEC, either as a cogeneration or small power production facility.

State Public Utilities Commission (PUC): The PUC does not regulate cogeneration facilities. The Federal Public Utilities Regulatory Policies Act (PURPA) of 1978, Sections 201 and 210, provides exemptions for qualifying facilities from regulation as a public utility. A cogeneration facility or small power production facility producing 30 MW or less is exempt under PURPA Sections 201 and 210 from certain sections of the Federal Power Act, all of the Public Utility Holding Company Act, the Natural Gas Policy Act and from State laws regulating electric utility rates and financial organization (Reference 10).

It is important to note that these regulatory exemptions and rate provisions are applicable only if a facility meets all qualification requirements as specified in Sections 201 and 210 of PURPA. Exemption procedures are described in the previous Department of Energy, Federal Energy Regulatory Commission section. In addition, a qualifying facility may only sell electricity on a wholesale basis; retail sales, regardless of facility capacity, would subject the facility to all regulations as a public utility company.

State Department of Industrial Relations: This Department inspects and issues the permit to operate a boiler.

State Solid Waste Management Board (SSWMB): The SSWMB is responsible for enforcement of all State and Federal regulations pertaining to solid wastes. Following the approval of a solid waste facility permit application by the local agency, the SSWMB has the final responsibility to concur or object to the issuance, modification or revision of such a permit. Determination is based on compliance with the County Solid Waste Management Plan and State standards.

State Department of Transporting (Caltrans): If the proposed project involves work on or an encroachment in regard to a right-of-way of the State highway, or development/maintenance of access to same, an Encroachment Permit must be obtained from Caltrans.

State Water Resources Control Board (SWRCB): Any solid waste management facility that discharges effluent to California waters must meet State and Federal requirements (State report of waste discharge and Federal NPDES permit) which are administered through the Regional Water Quality Control Board. Dependent on Federal permit determination, it may also be necessary to obtain a Project Certification from the SWRCB.

Regional

Association of Bay Area Governments (ABAG): If the project receives Federal funding from certain designated grant programs, ABAG will review the project plans and environmental documents in accordance with the Federal Office of Management and Budget's Circular No. A-95.

This project will also be reviewed for conformance to the Solid Waste Management Plan element of the Regional Environmental Management Plan.

Bay Area Air Quality Management District (BAAQMD): The District is responsible for attainment and maintenance of air quality standards as defined by the District itself, the California Air Resources Board and the EPA. It issues the permits to construct and operate, and is responsible for determining if New Source Review Requirements are met and the necessity of a Prevention of Significant Deterioration permit, which is subsequently processed by EPA. Mention should be made of the fact that the appeals board of BAAQMD has, in the past, overturned permit approval recommendations of its staff. This has been, in part, the result of strongly voiced citizen concern.

Regional Water Quality Control Board (RWQCB): The San Francisco Bay Area RWQCB is responsible for the protection of regional water quality as prescribed in the Water Quality Control Plan for the San Francisco Bay Basin. In addition, the Board enforces State and Federal regulations and holds authority to issue the Federal National Pollutant Discharge Elimination System (NPDES) permit.

Bay Conservation and Development Commission (BCDC): While the proposed project is outside BCDC jurisdiction and no permits or approvals are required, the Commission may want to review the project plans and EIR for informational purposes only.

East Bay Municipal Utilities District (EBMUD): A special district encompassing parts of Alameda and Contra Costa Counties, EBMUD operates sewage treatment facilities and a wastewater reclamation unit and provides water service for District communities. The District issues a Permit to Discharge to the system and authorizes water service.

Local

Alameda County Solid Waste Management Authority (ACSWMA): The ACSWMA is responsible for determining if proposed solid waste projects are in conformance with the County's Solid Waste Management Plan (SWMP) as required by State law.

City Planning Department: The Planning Department is responsible for the orderly development of land uses within the City. The Department processes zoning variances and use permits and reviews the initial project environmental impact assessment to determine if an EIR is required in conformance with the California Environmental Quality Act (CEQA). The process includes obtaining approvals from the following:

- Board of Adjustments
- City Council

City Public Works Department, Engineering Division: The Division, as part of its design plan check, issues a sewer connection permit and a storm drainage permit for discharge to these respective systems. The Department staff will also make a recommendation to the City Council regarding the proposed project.

City Housing and Development Department, Codes and Inspection Division: The Division is responsible for issuing Building, Electrical, Heating, Plumbing and Mechanical Permits; each requires separate application and inspections. Approval for grading is considered an element of the Building Permit. Through the Division's permitting procedure, approval should be obtained from the City Fire Department.

City Health Department: The Department issues no local permits applicable to the proposed project. However, the Department processes the State Solid Waste Facility Permit which is forwarded to the State Solid Waste Management Board (SSWMB) for final determination. The permit is issued only upon concurrence or modification by the SSWMB.

Berkeley Solid Waste Management Commission: As an advisory body, the Commission will review the proposed project plans and submit a recommendation to the City Council.

Table 8-1

REGULATORY AGENCIES

Federal

- *U.S. Corps of Engineers*
- *U.S. Fish and Wildlife Service*
- *U.S. Environmental Protection Agency, Region IX*
- *Department of Energy, Federal Energy Regulatory Commission*

State

- *California Air Resources Board*
- *Department of Fish and Game*
- *Department of Health Services*
- *Energy Resource Conservation and Development Commission*
- *Public Utilities Commission*
- *Department of Industrial Relations*
- *Solid Waste Management Board*
- *Water Resources Control Board*
- *Department of Transportation*

Regional

- *Association of Bay Area Governments*
- *Bay Area Air Quality Management District*
- *Regional Water Quality Control Board*
- *Bay Area Conservation and Development Commission*
- *East Bay Municipal Utilities District*

Local

County of Alameda

- *Alameda County Solid Waste Management Authority*

City of Berkeley

- *Planning Department*
- *Board of Adjustments*
- *City Council*
- *Health Department*
- *Public Works Department*
- *Housing and Development Department*
- *Fire Department*
- *Solid Waste Management Commission*

PERMIT PROCEDURES

The Office of Permit Assistance, State Department of Planning and Research, will facilitate the permit/review process by coordinating multi-agency/applicant meetings, scheduling public hearings as necessary, and monitoring the progress of permit applications. Under the California Environmental Quality Act (CEQA), Section 15035.7, the lead agency (the public agency with principal responsibility for project approval or implementation) is required to file a Notice of Preparation with the State Office of Permit Assistance (State Clearinghouse). The Notice identifies and describes the intent of the lead agencies to prepare project environmental documents. The Office will then coordinate with the lead agency to ensure that review agencies are properly notified and documents provided. Obtaining review approvals from nonpermitting agencies usually occurs before permits are secured.

An Environmental Impact Report (EIR) has been prepared for the Berkeley Solid Waste Management Center and submitted to the State Clearinghouse. Comments on the Draft EIR were received from the University of California, Berkeley, Alameda County Solid Waste Management Authority, State Department of Transportation, State Department of Fish and Game, State Solid Waste Management Board, San Francisco Bay Regional Water Quality Board and the Berkeley Solid Waste Management Commission. These comments and suggested mitigating measures have been incorporated into the project's Final EIR, issued in March of 1980.

In regard to the BAAQMD, Assembly Bill 524 which became State law in 1979 requires that permits for construction be issued for cogeneration technology and resource recovery projects, if the following specified conditions are met:

- *The project produces 50 megawatts or less of electricity.*
- *The appropriate degree of pollution control technology will be utilized as required by the New Source Review Rule of the District.*
- *The permit applicant has made a good faith effort in the judgment of the district, to secure all available emission offsets to mitigate the impact of the project. The applicant is required to obtain all available emissions offsets, as determined by the district.*

Under these provisions, a resource recovery project for which no emissions offsets are available may still be granted a permit.

Assembly Bill 884, passed by the California Legislature in 1977, requires that the lead agency approve or disapprove all project permits within one (1) year of receiving a completed application. Other responsible permit agencies must issue their decisions within six (6) months of the lead agency's decision or within six (6) months of receiving a completed application, whichever occurs later. Provisions for deadline extensions are made through mutual consent of the applicant and agency staff. Some agency decision periods are shorter than those specified in AB 884; the law is not applicable to Federal regulatory agencies.

The State Office of Permit Assistance will sponsor a pre-permit application meeting of all responsible agencies and project applicant; this meeting may be alternatively sponsored by the City of Berkeley, project lead agency. The purpose of such a meeting is to identify potential areas of concern that can be addressed in the project Draft EIR, and to

identify potential problems in obtaining permits. However, as the project Final EIR has been issued, a meeting of this nature is not appropriate for the current stage of project development.

The State Clearinghouse recommends that the CEC and PUC be notified of the project and the availability of the Final EIR for review; neither agency has been notified of the project through the State Clearinghouse procedure.

Negotiations should be initiated with the BAAQMD at this preapplication stage to reach agreement on emissions levels and appropriate control technology. The application for a permit to construct is not complete until such agreement has been reached and negotiations may take several months. An initial meeting with the BAAQMD was held in April, 1980 as mentioned in the discussion on Pollution Control Requirements, Chapter 5.

In addition, project sponsors should file an application for Initial Review for Conformance from the Alameda County Solid Waste Management Authority. The application requires information on the location and type of facility, type of wastes and projected processing capability, approximate service area and source of wastes, site information, proposed financing and management and a report on the status of other agency contacts. The decision period is forty-five (45) days, after which the permitting process may begin. Based on the Draft EIR, the ACSWMA has found the project to be in general conformance with the County's SWMP. However, a formal certification to that effect must still be obtained.

The permitting process will occur at many levels simultaneously. Figure 8-1 presents a representation of this process.

<u>City Planning Department</u>

Apply for a Use Permit (UP) and submit the final <u>Berkeley Solid Waste Management Center Environmental Impact Report</u> with the application. The UP application and EIR will then be presented at a public hearing before the Board of Adjustments; an appeal of the Board's decision, if applicable, may be made to the City Council for final determination.

Estimated time: 2 to 3 months.

<u>Alameda County Solid Waste Management Authority</u>

Submit the project Final EIR to the ACSWMA for a Determination of Conformance with the County's Solid Waste Management Plan. Applications for additional local permits should be deferred until an affirmative decision has been made and a resolution to that effect has been received.

Estimated time: 6 to 8 weeks.

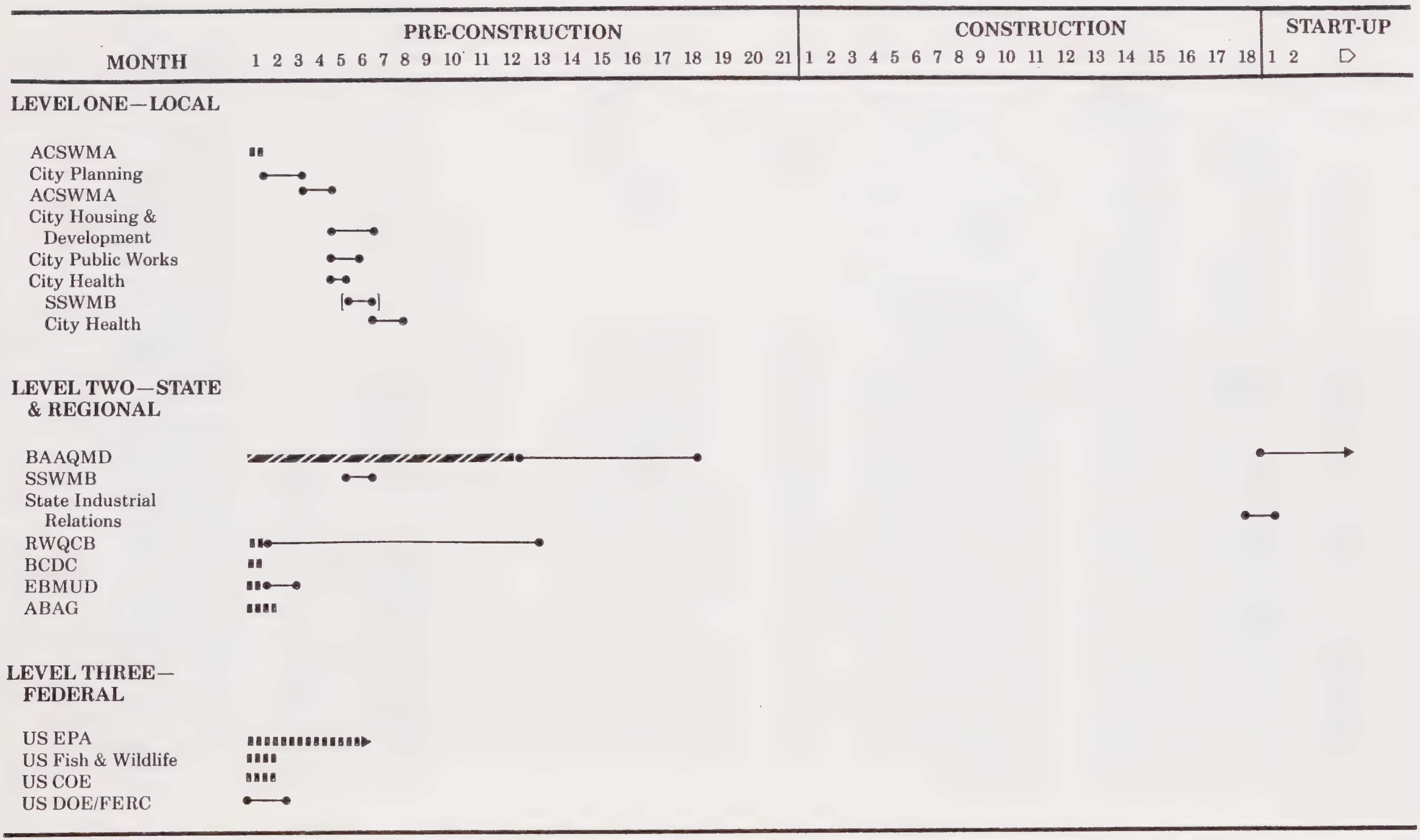
<u>City Housing and Development Department, Codes and Inspections Division</u>

Apply for Building, Electrical, Heating, Plumbing and Mechanical Permits. The Division requires two complete sets of plans for checking. It should be requested at this point that the Division forward necessary documents to the City Fire Department for their approval. The Department serves as coordinator for City permits.

Estimated time: 1 to 3 months, depending on complexity of the project.

Figure 8-1

*PERMIT & APPROVAL SCHEDULE**



* *assumes "best case" situation* — *permit process* — *review process* — *negotiations*

City Public Works Department, Engineering Division

Submit plans for checking; the sewer connection permit and storm drainage permit are considered part of the plan check and no formal applications are required. The Division may wish to review a wastewater analysis of cooling tower blowdown or any other discharge for informational purposes; a wastewater analysis is required for acid discharges.

Estimated time: 1 to 2 months.

City Health Department

Apply for State Solid Waste Facility Permit. The Department will make a preliminary decision and forward the application to the State Solid Waste Management Board for a hearing. The Board will review the ACSWMA's Determination of Conformance decision, and concur, disallow or modify the SWF permit.

Estimated time: 1 to 2 months.

Regional Water Quality Control Board

Project design includes the discharge of facility runoff to the San Francisco Bay through the existing storm drainage system. This discharge will require a National Pollutant Discharge Elimination System (NPDES) permit. In addition to the permit, periodic analyses and reports of wastewater discharge are required. The application is reviewed by EPA, Region IX.

Estimated time: 4 to 6 months.

During the project start-up phase, submit an ash sample analysis and request permission to dispose of ash at the Acme Fill Corporation Class II-1 landfill.

Estimated time: undetermined.

Bay Area Air Quality Management District

At the conclusion of preapplication negotiations, file an application for a Permit to Construct; the EIR or ND must be filed with the permit application. A permit to construct consists of the following "sub-permits":

- *Steam generator permit*
- *Pollution control equipment permit (one per stack)*
- *Waste permit (if wastes stored longer than one shift period)*

When in compliance, a permit to construct is issued.

Estimated time: 2 to 6 months, exclusive of preapplication negotiations.

After the facility has been checked out at capacity, a Permit to Operate and accompanying inspection is mandatory. This permit is issued only after source testing. The total time allowed to obtain these two permits is two (2) years, with continuances available as necessary. If all requirements can be met, the process may be shortened considerably.

<u>East Bay Municipal Utilities District</u>

Prior to filing a Permit to Discharge application, a meeting should be held to ascertain project requirements and potential wastewater discharge quantities and contents. If it is determined that a permit is necessary, the project must, in its permit application, meet all discharge specifications as required by EBMUD.

Estimated time: 2 months, or until project is ready to commence operations; a preliminary assessment of compliance may be obtained approximately two (2) weeks after application submission.

Apply for water connection approval; no formal permit required. Application for service may be made by letter or in person.

Estimated time: undetermined; dependent on construction necessary, if any, to provide service.

<u>Association of Bay Area Governments</u>

If applicable, submit project plans and EIR for OMB Circular A-95 review and regional Solid Waste Management Plan review.

Estimated time: 6 weeks

<u>State Department of Industrial Relations</u>

Apply for a permit to operate boiler when facility is ready to begin operations. After inspection and compliance, permit is issued. The Department covers only those boilers not covered by the City or authorized insurance company (with authority to inspect).

Estimated time: 2 to 8 weeks.

<u>State Department of Health Services</u>

As ash is currently classified by the State of California as a hazardous waste, haulers of ash must be registered with the Department of Health Services. An application should be submitted to the Hazardous Materials Management Section of the Department.

Estimated time: 1 to 2 weeks.

State Clearinghouse, Office of Permit Assistance

The Clearinghouse sent the Draft EIR for the Berkeley Solid Waste Management Center to several agencies as noted in the introduction to this section. The Clearinghouse, will also assist by monitoring State permit applications.

Estimated time: undetermined.

Environmental Protection Agency, Region IX

Apply for Prevention of Significant Deterioration (PSD) permit for attainment pollutants, if necessary, or present verification from BAAQMB and request exemption.

Estimated time: 30 days for notification of application completeness; 1 year after such notification to issue or deny permit. During this one (1) year period, there is a 30-day determination of intent to issue or deny permit; the application is then opened to public comment. If there is no significant public comment, the permit may be issued within 1 to 2 months; otherwise, public hearings must be held. Normal processing time is 4 to 6 months.

If an exemption is not possible and a permit is required, a preapplication period of 15 to 25 months must be allowed to prepare for and perform a 1-year monitoring program.

Estimated time: no time estimate for obtaining an exemption.

U.S. Corps of Engineers

No permits are required from COE. However, project design includes discharge of facility runoff to the San Francisco Bay (COE jurisdiction) through the existing storm drainage system. This discharge will require a NPDES permit (see RWQB); and, in addition, a letter should be obtained from COE verifying that the project has been reviewed and no action is required.

Estimated time: 1 month.

U.S. Fish and Wildlife Service

Due to potential impacts resulting from the project's proposed facility runoff discharge to the Bay, a copy of the project's EIR should be submitted for review and comment.

Estimated time: 2 months.

Department of Energy, Federal Regulatory Energy Commission

File an application for certification as a qualifying cogeneration facility under Sections 201 and 210 of PURPA.

Estimated time: 3 months.

PERMIT TIME REQUIREMENTS

It is estimated that a one-month preapplication negotiation and review period is necessary for meetings with the East Bay Municipal Utilities District, the Alameda County Solid Waste Management Authority, and an agency-wide meeting under the auspices of the Office of Permit Assistance or the City of Berkeley Planning Department, if appropriate. Preapplication negotiations with the BAAQMD will take considerably longer and commence in April, 1980.

The preconstructing permitting process may take from 9 to 33 months. The considerable variance in time is due to uncertainty regarding the necessity of a PSD permit and accompanying preapplication monitoring, the length of negotiations necessary to file a complete, acceptable application for a BAAQMD Permit to Construct, and the period of time the lead agency may take to issue a Use Permit.

The remaining permitting time is estimated to be 2 to 3 months and will occur during the final construction and initial project start-up stages.

CHAPTER 9

FINANCING, RISKS, PROCUREMENT

INTRODUCTION

The following sections present the financing and procurement options for a transfer station/materials and energy recovery facility and the risks associated with pursuing resource recovery. A special discussion is presented of the risks of not pursuing any of the solid waste management alternatives being considered by this study. Recommendations with respect to project financing, procurement and risk allocation were discussed in Chapter 1.

FINANCING ALTERNATIVES

The following discussion on financing alternatives was prepared by Blyth, Eastman, Paine Webber. Their report is presented in Appendix L and summarized below.

Public Ownership Options

In the discussion which follows, emphasis is placed on public debt financing methods involving the issuance of tax-exempt municipal bonds. Political bodies which are qualified to issue such bonds can borrow at lower interest rates than private borrowers of similar credit worthiness. In addition to tax-exempt municipal bonds, the City could use the monies accumulating in the City's Refuse Disposal Development Fund. These monies could be used for a variety of purposes including (1) to pay for a part or all of the transfer station portion of the project, (2) to acquire nonqualifying portions of the project, such as a turbo-generator, or (3) to set a reserve or contingency funds for the generation of the project.

The following public bodies may issue bonds for a resource recovery facility to be located in Berkeley:

- *the City of Berkeley;*
- *the County of Alameda;*
- *a Joint Powers Authority (JPA);*
- *a nonprofit corporation; or*
- *a Special District.*

Debt financing instruments which may be issued under current law by some or all of the possible issuers above are:

1) *Revenue Bonds;*
2) *Lease-Revenue Bonds; or*
3) *Bonds secured by a pledge of taxes.*

Revenue Bonds: *Local government entities can issue traditional "revenue bonds" to finance acquisition of "enterprise" facilities which can stand as independent economic units. Such bonds are secured solely by a pledge of the revenues from a certain income-generating facility, and the credit and taxing power of the local government entity are not pledged or committed to pay debt service on the revenue bonds. A solid waste disposal project which receives income from tipping charges and sale of energy or recycled products would be a logical candidate for financing with revenue bonds.*

A local agency may issue bonds for the acquisition, construction or improvement of any enterprise. "Enterprise" is defined as a revenue-producing undertaking for, among others, "the collection, treatment or disposal of garbage or refuse matter." The scope of collection, treatment or disposal includes but is not limited to "garbage trucks, equipment, landfills, garbage disposal plants, and incinerators or other disposal facilities, including facilities to convert solid waste to energy and reusable materials."

Prior to the issuance of bonds, the legislative body of a local agency must adopt, by a majority of all members, a resolution to submit to the qualified voters the proposition of issuing bonds. Authorization for the issuance of bonds requires a majority approval of the electorate voting on the proposition. It is important to note that a local agency is explicitly granted the power to require its inhabitants to use the resource recovery facility exclusively, thereby assuring a steady flow of solid waste and attendant revenues.

A local agency may contract with persons to design, construct or operate the facility. The term of such contracts may be for any period not exceeding the time when the principal and interest of all bonds have been fully paid. Any such contracts must be awarded to the lowest responsible bidder and all contracts must be approved by the affirmative vote of four-fifths of the legislative body.

Bondholder security for a resource recovery project so financed would be derived firstly from the local agency's ability to set rates and charges sufficient to cover debt service and operation and maintenance, and secondly, from the strength of the energy sales contract. A level of protection may be obtained by a "take or pay" contract whereby the energy user would agree to take a minimum quantity of energy and pay a minimum amount for it if it is available, whether or not it would be used. In a "take or pay" contract, the user would pay only for the amount of energy it actually received.

Advantages:

- waste flow control powers are explicitly granted
- a two-thirds vote of the electorate voting on the proposition is not required

Disadvantages:

- revenues must support contingencies, debt reserve funds and coverage ratios with a "take or pay" contract
- all procurement must be competitively bid
- subject to interest rate limitations
- a majority vote of the electorate voting is required

City of Berkeley as Issuer

The City of Berkeley would be a logical choice to act as issuer of the bonds if the facility were designed to handle wastes generated only within the City's boundaries. The City would retain total control over the facility and its operating the facility with City personnel or through a contract with a private firm, determining the types of covenants to be included in the bond resolution, etc.

The City of Berkeley has no provisions in its charter dealing with the issuance of revenue bonds. Therefore, the City is free to establish, by ordinance or charter amendment, whatever provisions it desires with regard to the authorization and issuance of revenue bonds to finance municipal projects. This means that the City of Berkeley may issue revenue bonds to finance its Solid Waste Management Center without the requirement of a vote of its electors, and without any interest rate limitation. In any event, some citizen involvement in the issuance of revenue bonds would be assured because to issue such bonds, the City would have to adopt a procedural ordinance setting forth the conditions for the issuance of revenue bonds. This ordinance would be subject to referendum under provisions of the Berkeley City Charter, so that if a sufficient number of citizens opposed the ordinance, its adoption could be subject to voter approval pursuant to the referendum provisions.

The County of Alameda as Issuer

While it is technically possible for the County to act as issuer, it is unlikely that voters would approve a proposition to issue bonds for a facility whose major beneficiary would only be the City of Berkeley. Even if voter approval could be obtained, this option would not be desirable from the City's standpoint since it would lose operational control over the facility. This would expose the City to the possibility of uncontrollable increases in the price for disposal and would preclude its input in a bond resolution and energy sales contract.

Joint Powers Authority as Issuer

If authorized by their legislative or other governing bodies, two or more public agencies (e.g., the City of Berkeley and the County or another city, public corporation or district) may jointly exercise any power common to the parties, as for example acquisition, construction and operation of a resource recovery facility. The resulting agency (joint powers authority or JPA) constitutes a new public entity separate from the parties to the agreement. Recently, JPA's were empowered to issue revenue bonds to finance resource recovery facilities under the 1941 Revenue Bond Law.

While it might make sense to use JPA (particularly if a number of other municipalities are to use the facility) and whereas the City, as a party to the agreement, could still exercise substantial control over the project, from a credit point of view, it would be more desirable to issue lease revenue bonds as opposed to 1941 Act revenue bonds. This is because the credit of the leasee public entity would be pledged for the lease payments as opposed to the pledge of project revenues, and this would enhance the rating of the bonds. Furthermore, under the 1941 Revenue Bond Law, the JPA would have to incur the time and expense of a voter election on the proposition of issuing bonds, while such election would not be required with lease revenue bonds.

Special District as Issuer

While it is theorectically possible for a special district to issue bonds under the 1941 Revenue Bond Law, it is unlikely that the formation of such a district would be approved by the Local Agency Formation Commission.

Lease Revenue Bonds: *For lease revenue bond financing, a public agency such as a specially formed nonprofit corporation or a joint powers authority issues tax-exempt revenue bonds to finance the cost of constructing a facility to be leased to a public entity such as the City or the County.*

The sole security for bonds of this type is the lease for the completed facility for an annual rental at least equal to principal of and interest on the bonds. The lease may also require the leasee to operate and maintain the facility or to pay for such expenses through additional rental. The lessee may, in turn, use project revenues as the source of rental payments but may also use other sources of revenues legally available to it (e.g., the City's Refuse Disposal Development Fund). Structuring of the financing in this way allows the bonds to obtain the credit backing of the lessee public entity, which is normally about one level lower that that entity's general obligation bond credit rating.

A major advantage to the use of lease revenue bonds is that authorization for their issuance usually does not require voter approval. No such approval appears to be required under the Berkeley City Charter. In addition, lease payments made by the leasee are not considered debt counting against any statutory debt limits (except for the County) and are treated as an operating expense of the lessee.

Advantages:

- *lower annual costs of the project*
- *sources other than project revenues are available for bond security*
- *voter approval usually not required*
- *no need for coverage of debt service*

Disadvantages:

- *may be subject to interest rate limitations*

Nonprofit Corporation as Issuer

A nonprofit corporation (NPC) may be formed by or on behalf of a municipality. Directors of the NPC must be appointed by or approved by the municipality that will receive the NPC's assets upon retirement of any indebtedness incurred. An NPC may be subject to possessory interest taxes on its facilities, and comments relating to competitive bids and budget limitations of a JPA (below) apply also to an NPC.

Costs of bond issuance might be higher and the time required might be longer than for a JPA, because of the approval needed from the California Commission of Corporations and a no-action letter from the Securities and Exchange Commission. Compliance with blue-sky and other securities laws of the various states must also be made to offer bonds therein.

Joint Powers Authority as Issuer

A JPA must offer its lease revenue bonds at public competitive sale if the lease payments are made by a public entity and the par values of the offering ex-

ceeds $500,000: Proposition 4 may affect the ability of the leasee to include in its budget sufficient moneys to make lease payment. Prior to passage of Proposition 13 and 4, lease revenue issues were usually rated one grade below the lessee's general obligation bond rating.

Special District as Issuer

Theoretically, it may be possible to form any number of special districts for purposes of financing the proposed resource recovery facility (e.g., County Sanitation or Sanitary District). However, entities of this type would require the approval of the Local Agency Formation Commission (LAFCO). It is unlikely that LAFCO approval could be obtained. As such, this option is dismissed as being without merit in the present situation.

Bonds Secured By Pledge of Taxes: *Traditionally, the safest and lowest cost form of borrowing for local governments has been through bonds which are secured by a pledge of the taxing power of the local entity, rather than by a pledge of revenues from an income generating enterprise. In California, cities had the power to issue General Obligation Bonds which were secured by a pledge to levy property taxes unlimited in rate or amount sufficient to pay the debt service on the bonds. The issuance of such bonds was subjected to two-thirds voter approval and was subject, in the case of charter cities, to restrictions in the charter on the maximum amount of indebtedness (usually expressed as a percentage of the assessed valuation of properties in the city) which could be incurred.*

Traditional general obligation bonds were terminated by the passage of Proposition 13 in June, 1978, because Proposition 13 set a maximum one percent limit on the rate of property taxation, which is inconsistent with the unlimited pledge necessary to create general obligation bonds. State Proposition 4, which was defeated on the November 1980 ballot, would have restored the ability of local governments to issue traditional general obligation bonds under the same conditions as had existed prior to 1978.

An alternative method to issuing traditional general obligation bonds is available under present California law. Cities can issue bonds secured by a pledge of certain taxes. The legislation permits cities to finance the acquisition of public facilities through bonds secured by a pledge of sales and use tax revenues. Under this law, bonds may be issued only after two-thirds voter approval. Furthermore, the amount of bonds that may be issued may not exceed an amount, the debt service on which will require more than two-thirds of the sales and use tax revenue of the city in the year that the bond election is called (e.g., the statute maintains a "coverage" of one-third of the sales taxes to offset any possible reduction in sales tax revenues in future years). These bonds are not a pledge of the credit or taxing power of the city in question, and are limited obligations secured solely by the pledge of sales and use taxes.

Advantages:

- *lowest cost interest rate*

Disadvantages:

- *severe constraints imposed from recent legislation and initiatives*

Private Ownership Options

The purpose of this section is to discuss a method of tax-exempt financing whereby ownership of the facility and a number of Federal tax benefits would rest with the private sector. These benefits, including investment and energy credits, deductions for

accelerated depreciation and interest expenses, are substantial and could be used to the economic advantage of the project in the form of a lower cost of disposal to be charged to the City. It is important to recognize that while a number of other sources of loans and capital are available to private corporations, very few resource recovery projects have been financed on a totally private basis through such mechanisms of capital formation as stocks, debentures or loans. Current economics of resource recovery simply do not allow for a satisfactory return on investment when compared with other investment opportunities a private firm might have.

Industrial Development Bonds: *Currently, in the State of California, industrial development bonds (IDB) for a resource recovery facility may be issued by the California Pollution Control Financing Authority (CPCFA). IDB are a form of tax-exempt financing which must meet specified Internal Revenue Service (IRS) regulations. The complex regulations are continually being interpreted and applied by the IRS. Approximately 70-100% of the total project cost for the proposed facilities could be financed by IDB, depending on the scenario.*

In a typical CPCFA financing, the Authority, as lender, lessor or seller, and a private corporation enter into a long-term contract pursuant to which the private concern makes periodic payments based upon the project costs, interest rates and the useful life of the facility. The Authority funds the contract by issuing its revenue bonds secured solely by the credit of the private concern plus other collateral such as a mortgage on the project, and a pledge of the revenue arising from the operation of the facility. The Authority acts solely as a vehicle for tax-exempt financing and neither the credit of the State nor that of any local government body is pledged for repayment of principal and interest on the bonds.

CPCFA may issue bonds for a private concern in any amount and without regard to statutory limitations on interest rates. The proceeds of such bonds may be used to finance transfer vehicles, transfer stations, source separation facilities, land, buildings and any facilities used for the collection, storage, treatment, utilization, processing and final disposal of solid waste. Bond proceeds may also be used to finance engineering, related professional and financing costs and administrative fees.

Advantages:

- *some tax benefits associated with resource recovery are utilized*

Disadvantages:

- *must meet complex IRS regulations*

Leveraged Leasing: *A leveraged lease is a form of project financing that involves the leveraging of an equity investor's funds and the pass-through to the user/lessee, in the form of lower lease rentals, of the tax benefits inherent in the ownership of the project. An economic prerequisite usually is that the tax benefits of ownership can be utilized more effectively by the equity investor, as owner/lessor, than by the user/lessee. Principal among such tax benefits are the investment tax credit and deductions for accelerated depreciation and interest.*

In the event the user/lessee is able to take full advantage of the tax benefits of ownership, there may be little economic justification for engaging in leveraged leasing.

Leveraged leasing can be used for the financing of virtually any kind of property except nondepreciable land and certain types of property which the Internal Revenue Service considers "limited use property" (i.e., property which will probably be of little or no use to potential lessees or buyers, other than the lessee or its affiliates, at the end of the lease term).

In leveraged leasing, equity investors acquire the project to be leased prior to its in-service date for tax purposes through a specially-created ownership trust or partnership. Their investment must be at least 20 percent of the cost of the project. The balance of the cost of the project may be raised through industrial development bonds or it can be obtained from the issuance by the trust or partnership of its long-term obligations. The debt financing is without recourse to the equity investors obligations and is secured only by an interest in the project assets and an assignment of the lease. The equity participants' return on investment is derived from (a) the net cash flow available from lease rentals in excess of debt service, (b) the tax benefits of ownership and (c) the residual value of the project.

The institutions providing the debt portion of the financing look primarily to the ability of the lessee to make timely rental payments and to the collateral value of the project. Of course, the lenders have a claim on lease rentals prior to that of the equity participants.

Leveraged leasing can produce significant savings in financing costs whenever the user cannot fully utilize the tax benefits associated with the project. This may occur because of substantial investment tax credits or reduced tax liabilities resulting from special deductions or net operating loss carry forwards. When this situation exists, the lessee may gain more from the reduction in financing costs than will be lost through passing the tax benfits through to the lessor.

Advantages:

- *separates owner from user, while retaining tax benefits*

Disadvantages:

- *requires explicit approval from IRS*

Federal Funds

In an effort to encourage domestic production of energy, the U.S. Congress has passed P.L. 96-126, The Department of the Interior and Related Agencies Appropriations Act for FY 1980 and P.L. 96-304, FY 198 Supplemental Appropriations and Recessions Act. Appropriations, administered by the Department of Energy, earmarked for commercial production of alternative fuels are $200 million for cooperative agreements. The Government share is not to exceed $25 million on any one project. It is anticipated that the project proponent will share, at least, 50% of the costs. Repayment may be required and would be generated from facility revenues, spread evenly over a five-year period, commencing with plant startup. These terms and conditions may be subject to negotiation.

PROJECT RISKS

The following discussion on project risk centers on those risks associated with pursuing the implementation of a resource recovery facility. The risk analyses, prepared by Gordian Associates, are presented in Appendix M. It is summarized below. Before resource recovery risks are discussed, a few brief remarks are made addressing the risk of not pursuing any of the solid waste management alternatives being considered.

Risks of Doing Nothing

The four solid waste management alternatives being addressed in this report are:

- *Transfer and Haul*
- *Transfer and Haul with Mechanical Materials Separation*
- *Materials and Energy Recovery - Cogeneration (Steam and Electricity)*
- *Materials and Energy Recovery - Electricity Only*

If the City elects not to implement one of these alternatives, City collection vehicles will be required to travel greater distances for refuse disposal after the City landfill closes. For vehicles designed for a long haul operation, this does not present such a problem as long as the distances do not become excessive. But for the City's collection fleet which is old and not designed for that type of operation, excessive equipment breakdown can be anticipated. To economically pursue the option, new collection equipment would need to be procured.

The closest landfill to the City of Berkeley, which has a greater life expectancy than the Berkeley Landfill, is the West Contra Costa Landfill located in Richmond. Using facilities in other counties will always pose risks. Importation bans or excessive disposal fees on outside county sources are both possibilities. The closest Alameda County disposal site will be the Davis Street Transfer Station located in San Leandro. The station is owned by Oakland Scavenger Company and is currently under construction. At these distances, however, transfer and haul become more economically attractive.

Resource Recovery Risks

Waste Stream Supply: Sufficient tonnage is currently disposed of at the Berkeley Landfill to fuel a resource recovery facilities even if recycling programs are promoted and expanded. However, the City controls through its municipal collection service only 30% of that total. Should the City implement an energy recovery facility designed on the full tonnage, the City runs the risk of opening doors to the energy recovery facility and finding the only wastes delivered is the City collected refuse. Wastes from other sources such as the general public or comercial enterprises could for a number of reasons (e.g., economic) take their refuse to neighboring landfills or competing resource recovery projects. To quantify the risk of receiving only City collected refuse, the economic computer model developed by the State Solid Waste Management Board (refer to Chapter 7) was utilized with the reduced tonnage. The first year disposal charge jumps to \$78 per ton from \$22 per ton for a cogeneration resource recovery facility receiving the full tonnage.

Some cities that have implemented resource recovery projects have inacted waste flow control laws. These laws require wastes generated inside jurisdictional boundaries to be delivered to the project. If Berkeley were to inact such an ordinance, approximately 30 more tons per day (seven day basis) currently disposed of at the West Contra Costa Landfill would become available for this project.*

*As a comparison of anticipated costs of energy recovery, existing Berkeley Landfill customers are currently paying $27 to $53** per ton depending on whether they are Berkeley residents. In 1985 dollars assuming 10% escalation per year the range is $44 to $85 per ton.*

Energy Markets: The commitment of Cal-Ink to purchase steam from the proposed facility is still questionable. The firm plans to conduct an investigation into its possible sources of future energy. Only after this investigation (to be conducted in the latter part of 1980) will their commitment be known. As was shown in the economic analysis, Chapter 7, the difference in the first year disposal charges of a cogeneration (steam and electricity) facility and a facility producing electricity only is $3 per ton in favor of cogeneration.

The financial stability and future plans of Cal-Ink represent another risk. This risk should be carefully weighed in structuring any contracts for product sale.

Disposal Facilities: Of the risks that will impact the costs of the proposed project, one of the greatest is associated with the disposal of residue. In view of the combustion ash being classified as a hazardous waste in California,the limitations on where it can be disposesd of are significant.

As was shown in Chapter 7, requirements to dispose of ash in Class I vs. Class II-1 sites increases the first year disposal charge at the proposed facility by $10 per ton.

As landfills which can accept ash reach capacity, the distance to new sites may increase significantly as may the attendant haul costs and disposal fees. The City or its representatives will need to secure facilities. There is also a need to have a contracted back-up or emergency landfill during periods of plant downtime or other periods when the recovery plant may be forced to close.

Facility Construction: Delays can result in greatly increased construction costs. If the City is timing the closure of its landfill with the start up of a new resource recovery plant, any significant delay could create a disposal problem and engender greatly increased costs for disposal.

Various risks are associated with project financing such as fluctuating interest rates, i.e., actual interest rate of debt service greater than anticipated, or simply difficulty in meeting the requirements for financing.

Changes in laws and regulations relating to construction specifications could also occur and that could increase the cost and delay the project. Lack of adequate insurance on the project, insufficient warranties, consequential and incidental damages due to a contractor's or subcontractor's failure to perform, lack of follow through on parent company guarantees, or simply lack of parent company guarantees, also pose potential risks. Such challenges as patent infringement or unexpected costs might cause delays, or otherwise frustrate the project.

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* *Refuse collected by Berkeley Sanitary Co.*

** *Assumes 150 lbs/cubic yard. Current prices $2.00/cubic yard for Berkeley residents and $4.00/cubic yard for nonresidents.*

Once the facility is fully constructed, it may be unable to meet acceptance tests such as failure to produce minimum energy outputs, or failure to demonstrate consistent performance at design throughput over a set time period. This often raises issues over the validity of the tests, the language in the acceptance criteria which may have been poorly drafted, or who performs and interprets the tests. There have been cases where projects have been held up for long periods of time when acceptance tests could not be met at the end of the construction period, and often litigation is required to resolve the problem of who is responsible for certain costs associated with facility performance. Several parties could be involved including the municipality, the system vendor(s), the designer(s), the contractor and various subcontractors.

It is significant to note that in the proposed project there is a risk of permit delay for the facility. There are a myriad of permits which will need to be acquired, perhaps foremost among them is the permit for emissions. Too, public hearings are required for any new source which would exceed 150 lbs. per day of any contaminant having limitations such as NO_x*, particulates, etc., and there is potential for this project to exceed that limit for some contaminants, particularly* NO_x*.*

<u>Facility Operation and Management:</u> Once the project is one-line, there are many areas where the risk of cost increase can occur: O&M costs higher than projected; quality and quantity of products different than expected; unscheduled outages or excessive downtime; inflation; force majeure situations; regulatory changes, etc. If the facility is owned or operated by a private party, there is the risk that an operator can turn away certain waste streams or fail to accept the waste as planned. Of course, many of these risks can be reduced and managed through a properly structured contract or series of contracts.

There are several operational aspects of the proposed project which have been identified as specific risks to be noted at this time. Key among these are generation of electricity via superheated steam and guarantees for such an approach. This risk is minimized by manufacturers, two of which are: (1) use of only $60^{o}F$ *superheat; and (2) the ability to bypass the superheat section in the event of failure and to provide dry saturated steam to the turbine with some loss in energy production (approximately 5%). The emissions control area also raises some risk considerations. Berkeley is in a nonattainment area and new sources of emissions will be carefully regulated. The system will have to meet Best Available Control Technology (BACT) requirements. To achieve this, a relatively new gravel-bed scrubbing unit has been proposed.*

The trommel also raises some risk considerations. The trommel as conceptualized is designed to make a three-way separation of the refuse inputed to it. The three-way separations are as follows:

- *A minus 2 inch fraction, the greater percentage of which is composed of glass and dirt;*

- *A plus 2 inch, minus 4.75 inch fraction, the greater percentage composed of organics and metals;*

- *A plus 4.75 inch fraction, the greater percentage ofwhich is composed of bulky organics.*

It must be understood that no operational trommel designed to make this three-way separation is on-line or has been tested on more than a pilot scale. Up to now, trommels in MSW processing have been utilized to achieve a two-way separation. Hence, opera-

tional data such as capacity and separation efficiencies are available for MSW trommels making two-way separations but not for three-way separations. The data on which the proposed installation is based has been supplied by Reynolds Metals Company, Richmond, Virginia, and has been derived from laboratory experiments with a 4' diameter by 12' long trommel. Reynolds has designed a 10' diameter by 40' long unit which has recently been installed in Houston, Texas.

The sophistication of an energy recovery plant and requirements for marketing recovered products dictates the use of private enterprise. However, the use of private enterprise poses some risks. Should the private operator default in any manner, the City will need access to the transfer portion of the facility to transfer for disposal the wastes collected. While contract stipulations can provide some assurance of access, access is guaranteed through ownership.

PROCUREMENT

Procedures

There are two basic procedures for procurement that are generally used in local government:

- *Nonnegotiated*
- *Negotiated*

Nonnegotiated: The nonnegotiated procurement procedure is the commonly used method for purchasing standard items or well-defined services. A document termed an Invitation for Bid (IFB) is used to solicit bidders. Since only a very limited exchange of additional information is permitted, the requirements must be completely and precisely described in the IFB. No deviations from the specifications are permitted. Award of the contract is made to the lowest responsible bidder. Use of the nonnegotiated procurement procedure involves:

Solicitation of bidders
Public opening and recording of offers
Preparation of abstracts
Public examination
Limited review
Identification of lowest bidder
Judgement on capability to perform
Award of contract

A modified, or two-step procedure, involves a preliminary document, a Request for Qualifications (RFQ). Discussions and exchanges of additional information is permitted. Disclosure of original proposal contents is avoided. Proposals may be publicly inspected only after contract award.

An IFB is then issued to all qualified offerors, and the procedure is the same as for the nonnegotiated method. Public disclosure of all bids is made with price becoming the primary criteria for evaluation. The following steps are involved:

Request for qualified proposers
Evaluation of responses
Solicitation of qualified bidders
(follows nonnegotiated method)

Negotiated: Negotiated procurement procedure can be either competitive or noncompetitive. Noncompetitive, or sole-source methods are often used in the hiring of professional services or to obtain a product that is unique. Negotiations involving more than one source are considered competitive.

Negotiated procurement is the method most often used to obtain complex systems and nonstandard items. Its main advantage is that a two-way exchange of information is permitted between bidder and sponsor. This presents the opportunity for considering alternative proposals and for coordinating requirements with bidders. It also provides an opportunity to consider the important interrelationships between technical, cost and management elements of a proposal.

In a negotiated procurement, a document referred to as a Request for Proposal (RFP) is used for solicitation. Award is based on a comprehensive evaluation of proposals using a predeveloped evaluation process. The negotiated procurement process usually involves the following steps:

- solicitation of proposers
- evaluation of proposals
- selection of finalists
- interview and rank finalists
- identification of winning proposal
- contract negotiation
- award

A negotiated procurement also lends itself to a multi-step procedure. In a two-step procedure, a RFQ is issued prior to the RFP, responses are evaluated, and then a RFP is issued to only the qualified proposers.

A summary of procurement procedures is shown in Table 9-1.

Acquisition

Five (5) basic practical approaches are available for acquisition of resource recovery systems. They are identified as follows:

- Conventional
- Turnkey
- Full Service
- Full Service with Government Ownership
- Modified Full Service

Figure 9-1 summarizes the five approaches, the associated government or private responsibility for each project element, and the procurement method. A discussion of each approach follows:

Table 9-1

PROCUREMENT PROCEDURES

	NONNEGOTIATION		NEGOTIATION	
	Competitive	Competitive	Competitive	Noncompetitive
Other Names	Formal Advertising	Two-step Advertising	Sealed Proposals	Sole Source
Requirements	Standard Items or Service	Reasonably Defined Items or Service	Less Well-Defined Items or Service (complex system nonstandard items)	Less Well-Defined or Proprietary Items or Service (products that are unique)
Documents (used for Solicitation which communicate requirements	Invitation for Bid (IFB)	1. RFQ 2. IFB	RFP (can be multi-step with use of RFQ	RFP
Offers	Public	1. Private 2. Public	Private	Private
Changes or Discussions	Limited (exchange of information)	1. Substantial 2. Limited	Substantial	Substantial
Evaluation & Selection	Price	1. Minimum Criteria 2. As Defined in IFB	As Defined in RFP, Price is Only One Factor	As Defined in RFP

Figure 9-1

Resource Recovery Acquisition Approaches

ACQUISITION APPROACH	PROJECT ELEMENT: DESIGN	CONSTRUCT	SUPV CONST	SHAKE DOWN	OPERATE	OWN	PROC METHOD	EXAMPLE
CONVENTIONAL	PRIVATE	GOVT					A&E DESIGN NON NEGOTIATED	AKRON OHIO
TURNKEY	PRIVATE				GOVT.		NEGOTIATED	TACOMA WASH.
FULL SERVICE	PRIVATE						NEGOTIATED	HEMPSTEAD N.Y.
FULL SERVICE WITH GOVT OWNERSHIP	PRIVATE					GOVT.	NEGOTIATED	BRIDGEPORT CONN.
MODIFIED FULL SERVICE	PRIVATE	GOVT.	PRIVATE			GOVT.	* NEGOTIATED	MONROE COUNTY N.Y.

* EXCEPT CONSTRUCTION ELEMENT

Conventional Approach: *This approach is the traditional one used by cities to procure public buildings and other construction projects. It involves two main steps. The first step is to hire an architect/engineer consultant to design the facility and draw up detailed specifications and drawings. The second step is to obtain the construction, material, and equipment through the nonnegotiated procurement method. This approach is almost always accompanied by government ownership and operation of the facility. Although this method gives the municipality full control of the project, it places the responsibility of system implementation, including initial process performance, on the municipality. It is most often used where there is a firm, committed government market, such as Ames, Iowa where the fuel fraction is used in a municipal boiler, or where there is a proven process technology.*

Article IX, Section 67 of the City Charter requires that for procurement approaches with government ownership each specific public improvement the expenditure for which exceeds an amount set by ordinance, currently $10,000, shall be done by contract authorized by resolution of the City Council. That section further provides that "said contract shall be let to the lowest responsible bidder after advertising for sealed proposal for five (5) consecutive days. . ."

Turnkey Approach: *In this approach a system contractor is hired to design and implement the resource recovery system in one package. The contractor is selected through the negotiated procurement method. This approach is always accompanied by the government ownership and operation where the municipality does not want to have the responsibility for system implementation. In addition to assigning sole responsibility for the project to a single party, it provides the municipality some assurance regarding initial process performance. If the plant does not operate as specified, the municipality does not have to accept it. This approach is often used where the market is less firm and process unselected. Conversely, many system contractors do not want to own and operate a plant, but are interested in the design and implementation package. This is especially true for patented and/or proprietary processes.*

The turnkey approach tends to offer the benefit of obtaining a more advanced process without the initial risk. An example of this approach is found in Tacoma, Washington where Boeing Engineering has designed and constructed a RDF plant for the City.

Full Service Approach: *The third basic approach commonly used in acquisition of resource recovery facilities is called "full service". It adds to the turnkey approach the elements of private ownership and operation. Thus, a systems contractor has full responsibility for financing, design, implementation, continued operation, and ownership. It makes public financing unnecessary and provides incentives for efficient design and operation by private industry. In reality, the full service contractor is offering the municipality a service instead of a facility. The system contractor will usually charge the municipality a dump fee for delivered solid waste. Hempstead, New York, is an example of this approach.*

For nongovernment ownership procurement approaches, Article XIII, Section 74, et seq of the City Charter permits the Council to grant franchises for public utilities and services without calling for bids. However, public hearings and prior notice for protests against franchise grants are mandated by the Charter.

Article VIII, Section 44(7) of the City Charter has further significance to the facility and its operation since it requires an ordinance for the "acquisition, sale or lease of public property". This provision is relevant as to the location of the facility on what is currently public property and as to sale of recovered products such as steam and/or electricity should such products be deemed public property.

Full Service with Government Ownership Approach: *The fourth basic approach is a variation of the full service approach where the facility is owned by government rather than private industry. The system contractor is responsible for the design, implementation and operation of the facility; thus, he is providing a service to the municipality while the municipality retains ownership of the facility. The advantage over the turnkey approach is that the same system contractor who designs and builds the plant is also responsible for its operation. This approach is becoming more common as technologies become more fully developed, because municipalities are more willing to own such facilities. This approach lends itself to a lease arrangement between the city and contractor. Bridgeport, Connecticut is an example of this approach. In this case, the Connnecticut Resource Recovery Authority (CRRA) will own the facility and Occidental Petroleum Corporation/CEA will provide the full service.*

Modified Full Service Approach: *The most original approach that has emerged from resource recovery acquisition is a hybrid, combining full service advantages with the requirement to adhere to competitive bidding laws that may mandate the use of nonnegotiated procurement. The arrangement involves government ownership and responsibility for procuring construction, equipment, material, and private responsibility for design, supervision of construction, shakedown and operation. It is used when a full service approach is desired, but competitive bidding laws must be met.*

Monroe County, New York used the negotiated method to select Raytheon Service Corporation to provide professional services and the nonnegotiated method to obtain the construction and equipment.

Decisions about who will own and operate the facility and financing method strongly affect the choice of the acquisition approach. Strong consideration should be given by the sponsoring entity not to "purchase" a resource recovery system in the same way (i.e., using the "conventional approach") it might purchase other capital facilities such as buildings or wastewater treatment plants. An alternative is to award a "franchise" to a private company using one of the "full service" acquisition aproaches described. Transfer stations, because they are less technically complex, can lend themselves to the conventional approach.

When soliciting proposals from industry to design, construct, and operate a resource recovery facility, it is desirable to be as specific as possible about the characteristics of the technology (the type of system) that is being sought. The degree of such technology specification is most dependent upon the firmness of markets for recovered products. If such markets are totally unknown, industry proposals should not even be solicited.

A Request for Proposal (RFP) Package is used to solicit proposals from industry. The RFP is the most important procurement document for communicating the requirements of the sponsor to the potential bidders. A checklist of RFP contents is given in Table 9-2.

Evaluation of industry proposals requires a highly qualified team experienced in resource recovery technologies, economics, marketing, and system management, as well as knowledge of the local area, its requirements and its politics.

Table 9-2

RFP CHECKLIST

CATEGORIES

GLOSSARY

GENERAL PROGRAM DESCRIPTION
- Purpose (subject) of solicitation
- Procurement approach (design, design & construct, etc.)
- Project goals/objectives
- Specific features of project/system
- History/background of project
  - Issuing sponsor
  - Authority of sponsor
- Selection team
- Proposal schedule
  - Bid briefing
  - Proposal due date (address and sponsor contact)
  - Estimated selection/negotiation dates

SYSTEM DESCRIPTION AND PERFORMANCE SPECS

Technical performance requirements
- Process restraints, preferences, requirements
- Detailed specs (A&E approach)
- Performance specs
- Process input/output description
- Refuse inputs
  - Quantity (municipal, commercial, industrial, etc.)
  - Composition
- Refuse Deliveries
  - Number and type of truck
  - Schedule
- Refuse excluded
- Quantity/quality of residual required
- Fuel and material product specs
- Type of transfer/transport required
- Arrangements required for residue sale/disposal
- Size of facility (capacity)
- Process redundancy/reliability requirements
- Receiving, storage and product/residue handling
  - Back-up landfill
  - Disposal methodology
- Future expansion/addition to facility
- Other provisions (e.g., visitors, signs, fences, etc.)

Management performance specifications
- Schedule (design & construction, test, operation)
- Management methodology and contracts
  - Contractor responsibilities
  - Control techniques
- Reporting channels
  - Program interactions
  - Participant responsibilities
- Auditing procedures
- Approval process (procedures, responsibilities)
- Labor & hiring specs (equal opportunity employer, etc.)
- Marketing responsibilities/arrangements
- Personnel qualifications

Financing
- Sources of financing anticpated
- Legal stipulations
- Financing goals of sponsor

CATEGORIES

- Fees and payments
- Escalator factors
- Revenue sharing

Environmental and aesthetic specifications

Contractual considerations
- Ownership (land, facility, refuse, landfill, products)
- Lease arrangements
- Process guarantees
- Performance bonds
- Liquidated damages
- Insurance
- Patent rights
- Royalties
- Payments and schedules
- Force majeure/risk sharing
- Tonnage guarantees
- Negotiable terms and conditions
- Re-opener clauses

PROPOSAL REQUIREMENTS

General
- Proposal bid bond or deposit (refundability, etc.)
- Submission deadlines
- Number of copies, page limits
- Issuer's financial and legal liability
- Amount of time proposal and bond are good
- Handling proprietary information
- Executive summary

Detailed proposal requirements
- Technical design proposal (reports, drawings, etc.)
- Management proposal (pert charts, flow diagrams, etc.)
- Bidder qualifications
- Marketing proposal (letters of intent, etc.)
- Financial proposal
- Cost assumptions (financing charge, rental fees, etc.)
- Pricing
- Environmental impact and aesthetics

EVALUATION PROCESS
- Methodology/approach
- Evaluation team - arrangements/participants
- Technique/format
- Evaluation criteria

APPENDICES
- Related reports
- Site information (soils, borings, access, etc.)
- Permit regulations/requirements
- State, local, federal, legal requirements
  - Environmental
  - Zoning
  - Building
- Sample contract or lease
- Letters of intent